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# Proceedings

## MILITARY OPERATIONS RESEARCH SOCIETY
## Mini-Symposium

MORS
MILITARY OPERATIONS RESEARCH SOCIETY

# ANALYSIS OF TACTICAL TRANSPORTATION: PROGRESS AND CHALLENGES (TACTRAN)


**Richard E. Helmeth**, Douglas Aircraft Company, Chair

Colonel **Michael D. McManus**, USA, OASD (PA&E), Co-Chair
**Lowell W. Jones**, ANSER, Co-Chair


**Proponent: Assistant Secretary of Defense (Program Analysis and Evaluation)**



**16 - 17 February 1988**

**Defense Systems Management College**

**Fort Belvoir, Virginia**

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This report contains written versions of 11 oral presentations made to the MORS Mini-Symposium entitled "Analysis of Tactical Transportation: Progress and Challenges (TACTRAN)" in February 1988. The objective of the mini-symposium was to provide a forum for the discussion of several concurrent efforts to examine the role of theater-level transportation and distribution assets in the outcome of combat operations.
Keywords: WIMS (Worldwide Intratheater Mobility Study); Data bases; Computerized simulation; Military transportation; Reinforcement of Europe; ATTMA (Advanced Transport Technology Mission Analysis);


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# CHAPTER 1

# INTRODUCTION

by Richard E. Helmuth

## 1.1 FOREWORD.

Several major study efforts which examined contributions of and requirements for tactical transportation in combat operations were completed in 1987. Availability of these study efforts inspired the organization of an event to discuss analytical lessons learned in these and related ongoing studies. As a result, a mini-symposium with the theme "Analysis of Tactical Transportation: Progress and Challenges" was held 16 and 17 February 1988 in superb facilities made available by the Defense Systems Management College, Fort Belvoir, Virginia. The purpose of this mini-symposium was to make available to the analytical community the techniques and database from these recent study efforts: the how, why, and what; the assumptions, data development, and methodology development; and the challenges remaining. Terms of Reference as finally approved for this mini-symposium are included at Appendix A.

Proponents of this mini-symposium were the Office of the Secretary of Defense, Program Analysis and Evaluation, and the Military Operations Research Society (MORS). Dick Helmuth served as Chair, assisted by Co-Chairs COL Mike McManus, OSD(PA&E), and Lowell Jones, ANSER. A copy of the Announcement And Call For Papers is in Appendix B. A list of the attendees is included in Appendix C.

TACTRAN was a very intense two day event addressing a wide range of work and issues in the field of tactical transportation analysis. Many who would benefit from the information presented at this event were not able to attend, and those in attendance could reasonably be expected to digest only a fraction of the total information. To provide wider dissemination of the TACTRAN presentations, Dick Helmuth summarized the mini-symposium in a General Session at the 56th MORS, and this document has been prepared for publication and distribution by MORS.

For the most part, papers which are part of this document begar as oral presentations. Following the mini-symposium, the Chair worked with the presenters to prepare a written version of the presentations. It should be recognized, therefore, that these Proceedings contain a written version of oral presentations, and are not formal papers.

These papers reflect the high level of past and current activity in analysis of tactical transportation. The pervasive influence which Army requirements, as still under development in the AirLand Battle Future and Army 21 studies, will have on the role and capabilities of tactical transportation in the future indicates that the issues identified in this report will continue to be the subject of analytical efforts. These Proceedings report on early efforts to develop appropriate tools and techniques, as well as lay some of the analytical foundation and database, for the major efforts soon to come. It is the hope then that the TACTRAN mini-symposium and these Proceedings will contribute to the success of future analyses of tactical transportation issues.

The remainder of this chapter contains introductory remarks by the Chair and a summary of other welcomes. It includes the complete Agenda of the mini-symposium.

Chapter 2 contains the Keynote Address which focuses on the history and role of the Worldwide Intratheater Mobility Study (WIMS) which was the cornerstone study for the mini-symposium.

Chapters 3 and 4 present the major findings of the WIMS effort and describe the development and use of the database and methodology.

Chapters 5 and 6 provide some background and overview of the issues involved in the analysis of tactical transportation. Chapter 5 presents an airlift perspective of tactical mobility while Chapter 6 examines challenges in modeling mobility from the perspective of studies conducted by the OJCS.

Chapter 7 presents work done by a field command (USAREUR) in evaluating the ability of the U.S. to reinforce Europe.

Chapters 8 and 9 present details of Army efforts to incorporate transportation modeling into Theater and Corps level combat simulations.

Chapter 10 describes ongoing Mission Analysis efforts by the Air Force to establish the analytical basis for development of the next generation tactical airlifter.

Finally, Chapters 11 and 12 present two similar, but different, approaches for evaluating the impact of tactical airlifters on combat operations by the use of combat simulations.

## 1.2 INTRODUCTORY REMARKS BY CHAIR.

Welcome to the "Analysis of Tactical Transportation" mini-symposium. I want to give a special thanks to MORS and to OSD(PA&E) for sponsoring this event, and to the MORS Executive Director, Dick Wiles, and his staff, Natalie Addison and Cynthia LaFreniere, for their invaluable assistance in organizing and supporting it. This would not have been possible without their expertise and dedicated work. I would also like to acknowledge my Co-Chairmen: COL Mike McManus, who you will hear a lot from today; and Lowell Jones, who is also Chairman of the Strategic Mobility Working Group for the next annual MORS Symposium in June. Among other activities, that Working Group in June will discuss a proposal to expand their charter to formally encompass tactical as well as strategic mobility issues.

We will hear an impressive set of speakers describe their work during these two days, and I encourage you to engage them and each other in discussions on questions raised by their presentations. I have asked the speakers to leave 10 to 15 minutes at the end of their presentations for questions and discussion. Because of the size of the audience, I ask you not to interrupt presentations for questions, but to wait until the discussion period. I also encourage you to comment on the relevance of your own work, or other work you are aware of, at that time.

The focus for this mini-symposium is the analysis process as opposed to final results. Studies are undertaken to assist the decision process and so naturally the emphasis of completed studies is on their results and

recommendations. These final products obviously are very important. However, their very importance often makes the studies controversial, proprietary, or highly classified so that the entire work is restricted from dissemination to the general analytical community. The purpose of this event, then, is to open up for professional discussion within the analytical community the recent advances in problems involving tactical transportation: the how, why, and what; the assumptions, data development and methodology development; the capabilities and limitations that can be brought to bear on this class of problems; and the challenges remaining. Be part of that discussion!

## 1.3 OTHER WELCOMES.

G. H. "Hork" Dimon, President of MORS, welcomed the attendees on behalf of MORS and its Board of Directors. He explained the purpose of MORS, its history, and its sponsors, and he encouraged the attendees to be a part of its future.

Brigadier General Charles P. Cabell, Jr., USAF, Commandant of the Defense Systems Management College (DSMC), Fort Belvoir, welcomed the attendees on behalf of the DSMC. He explained the role of the DSMC in preparing students for key positions in the defense acquisition process. Graduation from the DSMC is a prerequisite for selection as a Program Manager (PM), and the school places great emphasis on developing the appropriate logic or thought process in the student which is desirable for a PM. DSMC currently graduates about 600 students per year and will soon expand with enlarged facilities to about 1000 students per year.

## 1.4 TACTRAN AGENDA.

### 16 FEBRUARY

| | |
|---|---|
| 0900-0915 | WELCOMING REMARKS (Chair; MORS; Host) |
| 0915-0945 | KEYNOTE ADDRESS (Ms. Debby Christie - OSD PA&E) |
| 0945-1000 | BREAK |
| 1000-1200 | WIMS OVERVIEW (COL Mike McManus - OSD PA&E) |
| 1200-1300 | LUNCH (Fort Belvoir Officers Club) |
| 1300-1530 | WIMS DATABASE DEVELOPMENT AND USE (COL McManus) |
| 1530-1545 | BREAK |
| 1545-1630 | TACTICAL MOBILITY: AN AIRLIFT PERSPECTIVE (COL Al Shine - ACRA) |
| 1630-1715 | CHALLENGES IN TRANSPORTATION MODELING (Col Bill Smiley - OJCS/J4) |
| 1730-1900 | Mixer (Fort Belvoir Officers Club) |

### 17 FEBRUARY

| | |
|---|---|
| 0830-0915 | REINFORCEMENT OF EUROPE (Mr. Charlie Leake - SHAPE TECH CTR) |
| 0915-1015 | LINE-HAUL TRANSPORTATION IN THEATER-LEVEL COMBAT SIMULATION (CPT Greg Davis - USA CAA) |
| 1015-1030 | BREAK |
| 1030-1215 | TACTICAL MOBILITY: A CORPS-LEVEL PERSPECTIVE (CW3 Larry Haynes - USA TRAC-WSMR) |
| 1215-1315 | LUNCH (Fort Belvoir Officers Club) |
| 1315-1430 | DEVELOPMENT OF ATTMA DATABASE (Mr. Lud Vukmir - USAF ASD/XRM) |
| 1430-1515 | EVALUATING THE IMPACT OF AIRLIFT ON COMBAT OPERATIONS (Mr. Dick Lyons - LTV Aerospace and Defense Co.) |
| 1515-1530 | BREAK |
| 1530-1700 | USE OF VECTOR-3 CAMPAIGN MODEL FOR ANALYSIS OF TACTICAL TRANSPORT NEEDS (Dr. Seth Bonder - Vector Research, Inc.) |

Dick Helmuth has a BS from USMA and an MS in Math from RPI. During his Army career he was an Assistant Professor of Math at USMA, graduated from the Armed Forces Staff College, was Chief of the ORSA Branch at the Infantry School, and commanded the artillery battalion in the 197th Infantry Brigade. In his final assignment on the Army Staff, he was responsible for the integration of new concepts and doctrine, to include AirLand Battle, AirLand Battle 2000, and FM100-5, Operations. He is currently a Senior Analyst with Douglas Aircraft Company working on advanced military airlift programs. He has been Chair of the Joint Tactical Battlefield Operations Working Group (WG14), Chair of the Battlefield Environment Composite Working Group, and Co-Chair of the Strategic Mobility Working Group (WG 21) at MORS Symposiums. He is currently a member of the MORS Board of Directors.

# CHAPTER 2

## KEYNOTE ADDRESS

by Deborah P. Christie

I am pleased to be giving the Keynote Address today because of my long association with the members of the mobility community and my personal interests in mobility analysis. But more important, I am happy to be talking with you today because this symposium has as its goal the sharing of knowledge and ideas about the intratheater mobility problem. I believe that the utility of the study process, and the studies that will be presented here, lies not only in the conclusions that are drawn, but also in the development of a common understanding of a problem by the people and organizations that must resolve the issues addressed in our studies. This has been a constant goal for the Military Operations Research Society, and I am particularly happy that you have selected Intratheater Mobility as a topic for discussion in this symposium.

It is a common theme of Keynote speakers to commend the audience for their past performance and to exhort them to meet the challenges that lie ahead. I will not stray far from that theme in my remarks today. This symposium, however, marks a milestone in mobility analysis - the completion of the Worldwide Intratheater Mobility Study. I am happy to report that Colonel Mike McManus, the WIMS Study Director for the last three years, sent the final version of the WIMS report to the printers last Friday. This event signals the completion of a pioneering effort in the Department of Defense. Thus, a look back at the nature of that effort, its significance to the mobility community, and the challenges that it poses for all of us is particularly appropriate today.

The WIMS study was commissioned in the Spring of 1983. At that time, a variety of changes were occurring in force structure and operational concepts that created a great deal of uncertainty about the intratheater mobility task. These included revisions in Army doctrine such as the AirLand Battle 2000 concept; changes in force structure; and new concepts such as direct delivery and intratheater shuttle envisioned for the C-17. Oddly enough the very success of our strategic mobility programs also was

contributing to the uncertainty by changing the magnitude of the intratheater mobility task.

But the fundamental driver behind the WIMS study was not uncertainty, but ignorance. Looking back at the state of mobility analysis in 1983, there was a glaring imbalance between our ability to evaluate strategic mobility systems and our ability to assess tactical mobility requirements and capabilities. Under the direction of the Mobility Studies Steering Group, we had pursued several analytical efforts in the strategic mobility arena, and had developed an experienced, knowledgeable, and enthusiastic community suitably equipped with the required models and data bases necessary for conducting strategic mobility analysis. We had developed validated strategic mobility goals, and were vigorously pursuing our strategic mobility programs. No such body of knowledge or expertise existed for tactical mobility, however - a disparity that urgently needed to be corrected. Simply put, no analysis had ever addressed a total intratheater transportation requirement corresponding to the defense guidance scenario, nor had any previous analysis assessed our total intratheater capabilities, including air, land, and sea assets and the interactions and synergisms among them.

Because of the lack of force-wide assessments, common measures of effectiveness, or validated intratheater goals the Services had developed their own independent estimates of intratheater movement requirements, and were pursuing independent intratheater mobility programs. There was very little debate at the time over the need for intratheater programs, but there was considerable concern that such programs would be able to compete successfully in the absence of centrally validated goals and quantified benefits. This problem was recognized by members of the Mobility Studies Steering Group, specifically: Generals Ross and Smith, Admiral Avrit, and Mr. Mike Leonard. Fortunately those individuals had previously reached an agreement to cooperate and do what they could jointly to improve our mobility posture. And so, in March 1983, based on a proposal by Dr. Milton Minneman, the Secretary of Defense directed the mobility community to conduct a joint assessment of intratheater mobility requirements.

Recognizing that joint studies generally require a good deal of time, and that this was a particularly difficult subject to investigate, the Secretary allowed us six months. If he had allowed a year to complete the study, this symposium would still be an idea floating around somewhere in the back of Dick Helmuth's head.

As we began to tackle the task that we had laid out for ourselves, the absence of joint experience in analyzing intratheater mobility became readily apparent. One of our first serious efforts was in attempting to modify existing intratheater transportation models to meet our needs. Early on, we adopted a theater transportation model developed for Army line-haul transportation analysis. Our basic assumption was that aircraft could be modeled as larger and faster trucks, and ships could be modeled as huge trucks that operated exclusively at sea. In retrospect, it is clear that there are unique characteristics that differentiate airlift, sealift, and surface transportation systems, and these characteristics must be recognized and considered when modeling the total system. For example, airlift and sealift capabilities are constrained by the capacities of the nodes of the transportation system, while surface assets are constrained by the capacities of the paths as well as the nodes of the system. The need to model not only what is common to each transportation system, but also what is unique to each system, was the first real lesson learned in the WIMS study.

I would like to say that we learned the lesson of unique characteristics only once, but in fact we learned it several times! We learned it not only in the context of how to model systems, but in the context of how to measure productivity, and we learned it once again in the context of how to state requirements. As we passed through each phase of the study, we had to reestablish what was unique to each mobility system, and what was common to all systems. In my opinion, this was not a weakness of the study planning process, or of the participants. It was simply a consequence of the novelty, complexity, and diversity of the task we were grappling with. The magnitude of the study was so immense that in order to make any progress at all, we had to partition the effort at each milestone, and then at the next milestone, reassemble the pieces again. Needless to say, sometimes things just didn't fit back together until we

could accommodate in our methodology and approach what had been discovered to be unique. And so, as the final report is circulated, and as the techniques and terminologies developed during its preparation are absorbed by the mobility community, we will all benefit from the framework for conducting joint intratheater analysis developed by the WIMS analysts.

And there were a lot of WIMS analysts. Colonel McManus lists more than fifty participants in his final report, and in all probability, three or four times that many people participated either directly or indirectly in the study over its five-year life-span. Because of the projects duration, personnel turnover was a serious problem. As each generation of staff officers came on board, there was a learning process that had to occur. It slowed us down and made the job more difficult, but if nothing else, the WIMS study trained a cadre of mobility analysts who are now at least familiar with the capabilities, concepts of operation, and doctrine of each Service's intratheater mobility systems. I believe that the mobility community will benefit from this experience for some time to come.

A graduate of Duke University with a BS in mathematics, Debby Christie has spent her entire career in the analysis of defense issues. For the past 17 years, she has held a series of increasingly responsible positions in the Office of the Secretary of Defense which include 4 years as Director, Mobility Forces Division, Office of the Deputy Assistant Secretary of Defense (General Purpose Programs) and 6 years as Division Director, Projection Forces Division, Office of the Deputy Director (Theater Assessments and Planning) where she supervised many landmark efforts such as CMMS, Sealift Study, and WIMS. Last year she was promoted to her current position of Deputy Director (Theater Assessments and Planning) in the Office of the Secretary of Defense, Program Analysis and Evaluation.

# CHAPTER 3

# WIMS OVERVIEW

By COL Michael D. McManus, USA

ABSTRACT: In 1984, the Senate and House Armed Services Committees asked that the Secretary of Defense conduct a comprehensive tactical mobility study for their consideration. The Worldwide Intratheater Mobility Study (WIMS) is the basis for that response. The study examines intratheater movements associated with initial unit deployments, unit relocations, movement of supplies into and out of ports and depots, and many miscellaneous movements such as medical evacuees and malpositioned cargo. All modes, including rail, highway, pipeline, air, and water, are considered in the analysis. Major WIMS findings which were discussed included: (1) worldwide workload distribution of type cargos by theater and by transportation mode; (2) relative contribution of HNS, including the workload distribution by type cargo for HNS versus US transportation modes; and (3) general and mode specific findings.

## 3.0 PRESENTATION OUTLINE.

I - Background

II - WIMS Major Findings

## 3.1 BACKGROUND.

The Congressionally-Mandated Mobility Study, completed in 1981, and the DoD Sealift Study, completed in 1984, provide the basis for DoD's long-term goals for intertheater airlift and sealift and for pre-positioning. These successes led to concerns that projected intertheater capabilities would surpass the ability to move cargo forward within the theater. Experience had also made clear that centrally validated goals and benefits of intratheater mobility programs were necessary to their success. As a consequence, the Secretary of Defense directed the Worldwide Intratheater Mobility Study (WIMS) in March 1983 to establish

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Ed: Much of this presentation was classified SECRET. The classified material has been summarized in this paper so that the TACTRAN report may remain unclassified. This presentation was based on information contained in the WIMS Final Report (dated February 14, 1988). A complete copy of that report may be obtained from OSD(PA&E).

tactical mobility goals. The following year, the Senate and House Armed Service Committees and the Authorization Conference Committee requested studies of requirements for tactical mobility and of appropriate programs to eliminate shortfalls. These tasks were added to WIMS.

The purposes of WIMS were to assist the Secretary of Defense in setting tactical mobility goals which will complement the strategic mobility goals which were being realized, and to assess the capability of current programs to meet tactical mobility goals.

The specific objectives of WIMS are shown in Figure 3-1. Key among these objectives was the quantification of intratheater mobility workloads in various theaters, quantifying requirements for vehicles to meet these workloads, and the establishment of options capable of meeting tactical mobility goals.

It is equally important to note what WIMS was not intended to accomplish. It did not attempt to determine what would be the best mix of tactical transportation assets to meet the mobility goals. It did not attempt to quantify organic mobility requirements of any units. Finally, although it did examine host nation support (HNS) for U.S. forces in some detail, it did not examine HNS capabilities for all Allied forces.

A Southwest Asia theater evaluation was completed in September 1985, followed by a Pacific theater evaluation in early 1986, and a NATO theater evaluation which was completed in early 1987. A three-theater combined analysis was conducted in early 1987, followed by final evaluations, report writing, and reviews lasting until the Final Report was published in February 1988.

The study was an exceptional example of interservice cooperation as more than 50 analysts, representing all of the Services and the Office of the Joint Chiefs of Staff, made significant contributions to the study results. In fact, many times that number of Service representatives assisted in some aspect of the study development.

WIMS WILL:

- QUANTIFY MEASURABLE WORLDWIDE INTRATHEATER MOBILITY WORKLOADS
- QUANTIFY THE NUMBER OF TYPICAL VEHICLE REQUIRED
- QUANTIFY INFRASTRUCTURE UTILIZATION BY U.S. FORCES
- ASSESS HOST NATIONS' CAPABILITY TO PROVIDE REQUIRED LEVELS OF SUPPORT FOR U.S. FORCES IN HOST COUNTRIES
- QUANTIFY REQUIREMENTS THAT ARE POTENTIAL HNS CANDIDATES
- DESCRIBE MAJOR VARIABLES THAT AFFECT RESULTS
- ESTABLISH OPTIONS FOR TACTICAL MOBILITY GOALS

WIMS WILL NOT:

- DETERMINE OPTIMUM VEHICLE MIX AS PROGRAMMING OBJECTIVES
- SPECIFY REQUIRED VEHICLE CHARACTERISTICS
- QUANTIFY ORGANIC MOBILITY REQUIREMENTS FOR SPECIFIC UNITS
- ASSESS HOST NATIONS' CAPABILITY TO PROVIDE REQUIRED LEVELS OF SUPPORT FOR ALL ALLIED FORCES

Figure 3-1. WIMS Objectives.

The mobility spectrum as seen in WIMS covers the movement of forces through deployment and employment, including (1) from CONUS home stations to air and sea ports of embarkation, (2) intertheater movements to ports of debarkation, (3) intratheater movements forward from ports, and (4) tactical movements which fit under the umbrella of intratheater movements, but also include day-to-day battlefield operational movements. The treatment of these various movements is summarized in Figure 3-2.

| INTRA-CONUS | INTERTHEATER | INTRATHEATER | UNIT MOBILITY |
|---|---|---|---|
| NOT EXAMINED | MIDAS MODEL | MIDAS/SUMMITS MODELS | SUMMITS MODEL |
| | ALL THEATERS SIMULTANEOUSLY | EACH THEATER INDEPENDENTLY | NON-MOBILE ELEMENTS ARE MEASUREABLE |
| | AIRFIELDS, SEAPORTS IN DETAIL | AIRFIELDS AND ALL SURFACE INFRASTRUCTURE IN DETAIL | ORGANIC UNIT MOVES MAY COMPETE WITH COMMON USER LIFT |
| | SERVICES DATA BASE MOVEMENTS ONLY | DATA BASE, SCENARIO, WARFIGHT, AND OTHER SOURCES OF MOVEMENTS | SOME TACTICAL MOVES WERE MEASURED |

Figure 3-2. The Mobility Spectrum As Seen in WIMS.

Simply defined, an intertheater move occurs between theaters, while an intratheater move takes place entirely within a theater. From an operational standpoint where missions are better characterized by payload characteristics, lift assets required, or distance, the distinction between intertheater and intratheater is considerably less clear. For this reason, some moves which are intratheater by definition have traditionally been included in intertheater requirements because of the characteristics of the movement. Dry cargo examples include movement of

forces from Hawaii forward in the Pacific, forward deployment from staging bases in SWA, repositioning of prepositioned material in SWA, and movement of prepositioning ships from underway locations within a theater to various theater ports. For POL, all over-water movements have been included in intertheater tanker requirements. While recognized in WIMS, these movements have not been included in quantification of intratheater requirements because they have been previously included in other stated programming goals.

Other movements, not previously considered in strategic simulations but presented in WIMS as intratheater requirements, may actually be more appropriately considered intertheater missions because of the distances involved. For example, movement of small units and critical Navy cargoes around the Pacific by air; both SWA and the NATO flanks also have movements which are intratheater but could best be performed by intertheater systems. Rather than try to make a distinction between inter and intratheater movement requirements, WIMS includes both types as intratheater movements. In performing a capability assessment, judgements then have to be made as to the best way to satisfy the requirements.

When intertheater movement is by air, delivery to an airfield at or very near the final destination reduces subsequent intratheater movement requirements. The WIMS methodology permits as much of this sort of delivery as is possible within airfield constraints, aircraft availability, and the nature of the movement requirements themselves.

A direct interface between the intertheater and intratheater models has been created. MIDAS, the intertheater model, has the capability to make deliveries to notional Aerial Ports of Debarkation (APODs) and Sea Ports of Debarkation (SPODs) within destination theaters, or look at individual APODs and SPODs and limit deliveries to actual capacities. For specific airfields, this is described as weighted sorties per day. For seaports, it is described in more detail, to include types and numbers of piers, the kinds of ships that may utilize a pier, and the tonnage capacity of the various kinds of ships at that type of pier.

WIMS includes the movement by road, rail, pipeline, water, or air of equipment, personnel, all classes of supply, and potable water. Organic movement is considered a viable mode of transport, because it does present an alternative to common-user lift. Within each theater the study includes the following parameters:

- Forward movement of units and supplies from PODs to initial operating locations or supply points.

- Movement from staging bases or prepositioning sites.

- Preplanned relocation of units based in the theater.

- Resupply in operating locations.

- Relocation of units or supplies in response to the exigencies of combat.

- Movement within or in the immediate vicinity of a port, airfield, or supply point.

- Movement by air of medical supplies and evacuees.

- Surface delivery of mail.

- Repositioning of cargo delivered to the wrong location.

- Retrograde of combat damaged vehicles is not included.

- Evacuation of non-combatants was assumed to be accomplished from intertheater airfields on backhaul aircraft; non-combatants were assumed to be able to move to the airfields by their own means.

To handle high priority requirements not included above, airlift channels are established and a portion of resupply, POL, and ammunition is earmarked for movement by air.

Supplies are delivered to nodes designated as destinations for consuming units. In the case of divisional units, these nodes are assumed to represent the brigade rear areas. In the case of nondivisional units, these nodes are assumed to represent the location of the direct support unit. Movements to consuming units beyond those nodes will be accomplished with organic transportation assets and are not modeled. In the case of Air Force units, the nodes represent major Air Force installations. Movements within the installation to consuming units are assumed to be accomplished with organic transportation assets and are not modeled.

The tactical movements accomplished by units with their own organic resources in support of day-to-day operations were an element of tactical mobility which was beyond the scope of this study. While the study did measure the requirements created by displacement of units which were beyond the units' ability to move themselves in a single lift, these requirements were aggregated by regions within the theater and not examined at specific unit levels, so no attempt was made to determine the relative mobility of specific units. Combat relocations which were modeled are those which are specified in the concepts of operation or caused by the specified movement of the Forward Line of Own Troops (FLOT). In this study, the movement of units with their own organic mobility assets was considered to be a viable mode of transportation, and was allowed to compete equally with other available modes.

The study includes the effects of enemy attacks on ports, airfields, and ground LOCs. Attrition of combat and support forces, either enroute or in the theater, is not considered in most instances. However, the NATO Central Region war game did provide combat postures for both Army and Air Force combatant units and both attrited and non-attrited simulations were performed. No attrition of lift assets or treatment of defensive systems aboard lift assets was included in the study.

Within each theater, certain functions are assumed to be provided by some source other than U.S. military forces. For example, in NATO's Central Region, host nations operate ports and move cargo forward from the theater rear to the Corps area. Some functions may be performed within a

Corps boundary. The term "Host Nation Support" normally refers to government-to-government agreements for support provided by the host nation's civil or military forces. In this presentation, however, the term will also be used to cover support provided under contractual arrangements between the U.S. and a private party (either local, U.S., or third country). The study quantifies the amounts of such HNS that are needed, but does not attempt to evaluate fully the ability to provide this support. Doing so would require data on non-U.S. movement assets and on competing host nation military and civil movement requirements that are not available. Instead, requirements are tested for reasonableness against existing agreements or total host nation capacity.

### 3.1.1 WIMS Methodology.

Figure 3-3 displays the relationship between the functions which contribute to the calculation and analysis of intratheater movement requirements. They can be summarized in four categories; Information Sources, Simulation Models, Analysis, and Products. The following discussions amplify each of the major functional areas and describe in some detail how the study was conducted.

A deliberate effort was made to incorporate in this study the best information available. Sources of information include doctrinal publications, extracts of service planning documents, memoranda, verbal discussions, and modified data bases.

In addition to providing the programming scenario timeline, the Defense Programming Guidance specifies an allocation of major combat forces to specific theaters. The scenario and the allocations of forces are the principal elements of the planning framework which the Services use to build their mobility analyses data bases, develop detailed concepts of operations, and conduct war games in support of many programming-related efforts. WIMS is a programming based study. This is an important point, because many studies conducted in various theaters are derived from various OPLAN allocations of forces and are not comparable to a programming guidance allocation.

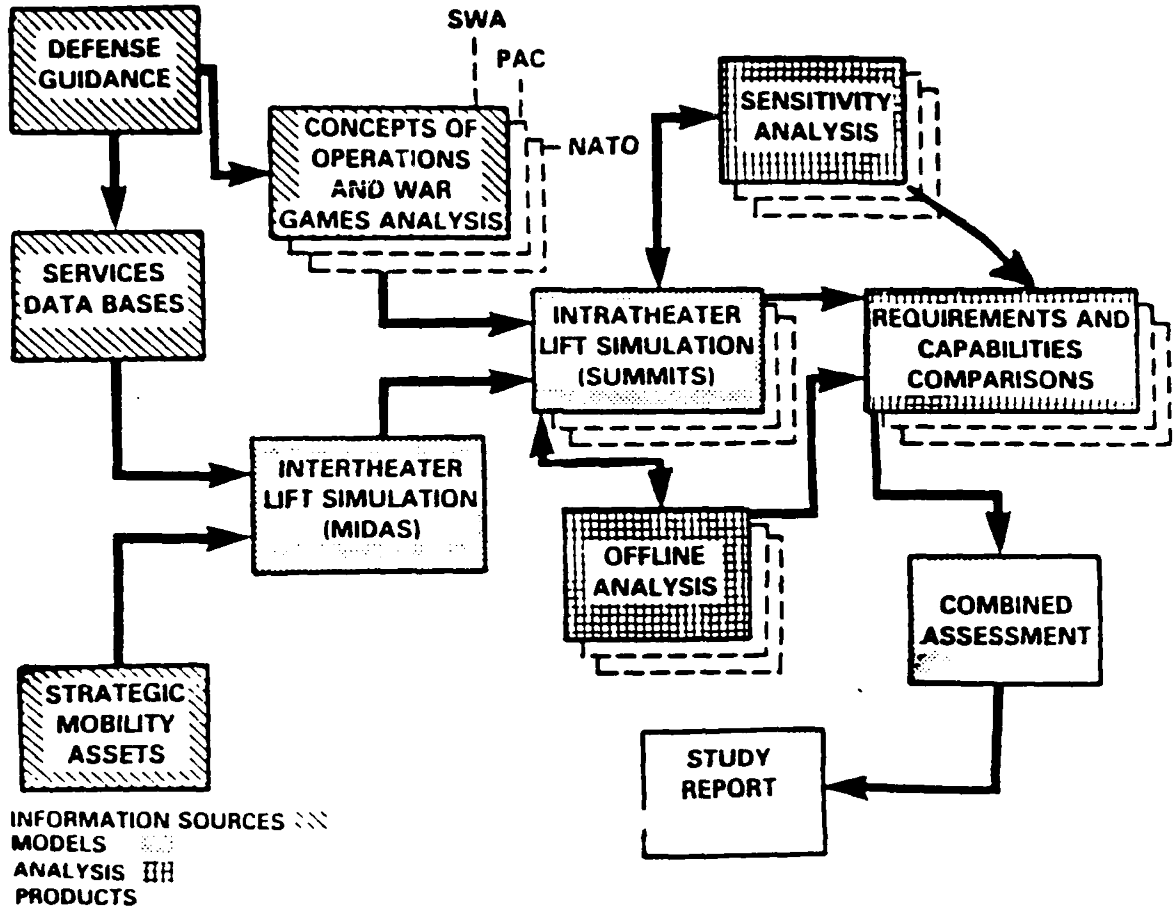


Figure 3-3. WIMS Methodology.

Given the framework of the programming guidance, the Services develop mobility data bases as part of their Program Objective Memorandum (POM). While POM preparation instructions provide additional guidance, the Services have considerable latitude in the development of these products. The data bases contain descriptions of the major combat and support units. These descriptions include the required delivery date and deployment characteristics such as weight for each unit. One of the conclusions reached in WIMS was that the latitude given the Services in the development of the data bases results in differences which go unnoticed in intertheater mobility simulations, but which require considerable refinement for use in intratheater simulations. Much of the time spent accomplishing WIMS was devoted to data base refinement and validation.

Since one of the purposes for WIMS was to assist in setting tactical mobility goals to complement strategic mobility goals, the strategic mobility assets used in the intertheater simulations represented the long-term strategic mobility goals. The intertheater airlift fleet had a capability of 66 MTM/D; the sealift assets had a single lift capacity of about 1 million short tons of unit equipment and about 1.7 million short tons of containerizable ammunition and supplies. NATO and Korean airlift and sealift forces equivalent to those currently committed were also used. These assets delivered cargo to the various theaters somewhat earlier than is possible with currently programmed assets, and the intratheater requirements, which are a direct result of the intertheater closures, are similarly affected.

A Concept of Operations for each theater was developed in consultation with the staff of each theater CINC. The concepts specify the initial operating location of units, preplanned relocations from peacetime locations for forward-deployed units, and tactical relocations for various war game-supported analyses.

For SWA, the Joint Analysis Directorate of the OJCS conducted a war game for WIMS to estimate requirements for various emergency combat moves. In the other two theaters, the concepts were developed by J-5, in consultation with the Services and the CINCS, using existing war game results, other studies, and theater staffs' comments. While not related to specific OPLANs, the Concepts of Operations developed for WIMS resemble some plans in sufficient detail to make the study credible.

### 3.1.2 Simulations.

Most intratheater requirements are either the product of, or have been incorporated into a computer simulation. The following brief description of the various sources of movements and their relation to the simulations provides a general framework for explaining the analytical methodology related to calculating requirements.

- The intertheater movement analysis provides units and supplies arriving in the theater, most of which need forward movement to initial operating locations or supply points.

- Movements from staging bases or prepositioning sites are provided by the Services in the data bases.

- Relocation of units based in the theater in peacetime and movements in response to the exigencies of combat are derived from the concept of operations in each theater and from an examination of movements found to be necessary or desirable in war games.

- The intratheater simulation model used in the study computes requirements for the movement of supplies from supply points to operating locations and of potable water from sources to consumers.

- Offline analyses by study teams were done to estimate the need for airlift channels, aerial port unit relocations, emergency movement of supplies and POL by air, medical evacuation, mail delivery, and repositioning of cargo delivered to the wrong location. These movements were then manually inserted into the simulation to combine with the simulation-created movements.

- Some special operations were considered in the generation of movement requirements, and were included in the analysis to measure the impact of those events in relation to the generated common-user movement requirements. These requirements should not be considered all inclusive for special missions, as a separate study is currently being conducted to examine these requirements.

The Model for Intertheater Deployment by Air and Sea (MIDAS) was used to simulate movement of units and supplies from CONUS and Hawaii to the theaters. Except for a few units whose mode is specified by the Services, MIDAS selects deployment mode (air or sea). The output of this segment includes arrivals by ship in each theater and deployments by air to each theater. Ship arrivals include prepositioning ships. Even though MIDAS is an intertheater model, it plays an important role in determining

intratheater movement requirements. First, the apportionment of intertheater cargo to either an air or sea mode for delivery has a significant impact on intratheater movement requirements. Generally, deliveries to seaports have the furthest distance to travel to their final destination and create the largest movement requirements. Air movements generally are delivered closer to final destinations, which allows onward deployment of units to final destinatio-, with the use of organic resources; the requirement fo organic transportation support is smaller due to the shorter distances.

Second, the resupply movements (all classes of supply) generated by the intertheater model also affect the intratheater movements. This is a significant workload because all resupply requires handling and movement, while unit equipment does have some capacity to move itself. Further, resupply cargo generally will be moved more than once; from ports to depots, and again to consumers, while unit equipment generally moves through a marshalling area, if necessary, and then directly to a final destination. Resupply quantities may also vary significantly, depending on the theater stockage policy and the rate of build up.

Third, in MIDAS, the selection of the sea mode for delivery has the effect of causing ripples in the intratheater statement of requirements. Unlike air deliveries, which are low in tonnage per aircraft and generally arrive at a fairly steady rate, sea deliveries are substantially larger on a per ship basis and more irregular than air. Thus, a ship arriving at pierside and beginning its discharge causes an almost immediate increase in the movement throughout the network, and some peak requirements can be directly attributed to a ship arrival. In a requirements mode, it is useful to see those peaks, but in a capabilities assessment it is reasonable to assume that some of that cargo would sit in a holding yard with onward movements taking place on a regular basis, and that the peaks and valleys dampen out. The real impact of smoothing peak requirements caused by these ship arrivals can only be assessed by examining each ships' cargo in relation to the relevant RDDs.

The Scenario Unrestricted Mobility Model for Intratheater Simulation (SUMMITS) was used to estimate most of the intratheater movement requirements. In brief, SUMMITS is a scheduling model which can be used to estimate requirements for transportation assets (requirements mode) or to estimate the ability of a set of assets to meet some desired movement requirement (capability mode). The model schedules packages in priority order through a series of interconnected theater networks within the constraints imposed by node and link capacities and transportation asset availability. It will select the fastest path unless this violates user-controlled mode selection rules. Once a path is chosen, the model allocates both link and node capacity and transportation assets to move the package. Path selection is made with full knowledge of how capacities and assets will change in the future and of what has been allocated to higher priority moves. Therefore, SUMMITS provides a more efficient schedule than a "real world" planner would be likely to develop and, thus, sets a lower bound on requirements or an upper bound on capabilities.

In WIMS, SUMMITS was used in the requirements mode. In this mode, the model is provided enough aircraft and trucks of each type that path and mode selection is not influenced by a lack of vehicles, and the model generates the number of vehicles required to satisfy the stated movement requirements. Some deliveries are made ahead of required delivery dates. A post-processor was developed, therefore, to "stretch" these movements so that delivery was made just on time. Pipeline capacity in each theater was limited to existing or programmed capacity plus as much tactical pipeline as could be installed by the engineers allocated to that theater. Rail capacity was limited in each theater by a judgment as to the maximum likely to be available to U.S. forces.

Dry cargo movement mode calculations involve a complex set of variables. For example, air, which is very dependent on a limited infrastructure (airfields or landing sites), competes with all surface moves. Motor transport, which has virtually unlimited access to both origins and destinations and conceivably could satisfy all requirements, competes with rail or self-deployment as well as air. A key for mode selection is vehicle characteristics. Four principal variables interact in the mode selection process; payload, rate of movement, and load and

unload time. Since surface links were rarely saturated, the numbers of vehicles that could be employed were rarely limited, and payload was not a major factor in the choice among surface modes. Airfields frequently were saturated, however, so payload and rampspace utilization (of space and time) played a larger role in the allocation between air and surface movement. In general, only one notional vehicle was used for each mode and cargo type (dry cargo, POL, and passenger) pair. This was done because model logic was not designed to make choices among similar vehicles within a mode (e.g., 2 1/2T and 5T trucks). Excursions were made, however, to examine the effect to a mixed fleet of small and large aircraft versus a pure fleet of large aircraft.

In scheduling a move, the model examines every possible path through the network from origin to destination. Many paths are intermodal. Beyond a certain distance, when the faster speed of airlift overcomes the penalty associated with aircraft loading and unloading, paths with air segments will be faster than all-surface paths. It is possible, however, that surface movement may be fast enough to deliver cargo on time. The SUMMITS model includes logic to preclude the selection of air delivery in these cases.

The simplest way to express the mode selection logic is: if airlift and surface modes are competing for a movement requirement and if both modes are able to deliver early or on time, surface will be selected; if one mode is early or on time and one is late, the on-time mode will be selected; if both are late, surface will be selected unless air delivery is earlier by a user-specified number of days.

This discussion of the mode selection process within the model is key to understanding the generation of movement requirements. The data which displays tons is a reflection of tons moved. The same ton could have been moved from a seaport by rail, unloaded, driven to an airfield, loaded on an aircraft and flown to an airfield, with final delivery accomplished by motor vehicle again. Despite the distance traveled, the tonnage for each mode is the same. The contribution of the various modes is more accurately displayed showing ton-miles.

From SUMMITS, the study took the allocation of movement requirements among transportation modes (aircraft, truck, heavy equipment transporter, pipeline, rail car, and ship). For each vehicle type, the numbers of vehicles and the amounts of cargo moved were smoothed over the period between their availability and RDD, and then averaged over five-day intervals. This lowers the reported peak demand, but reflects the ability of transportation operators to defer lower priority cargo when workloads peak.

### 3.1.3 Analysis.

Analysis as a functional description is a continuous process through all study phases; examining input data, policies, and assumptions; development of the concepts of operations; and performance of manual calculations and simulations. In the context of describing the methodology of WIMS, however, analysis is considered to be one of the four principal study categories and relates principally to the collation of data derived in manual calculations or simulations, complemented by sensitivity analyses, and used to form judgments when compared to programmed or expected capabilities. The following comments explain the relationship of the various elements of analysis seen in Figure 3-3.

The SUMMITS model plays a central role in the analysis because it is the tool which allows rapid calculation of varying results as a function of changes in input parameters. Without this model, much of the study examination of modal trade-offs would not have been possible, nor would the examination of complicated variations in such things as the lines of communication in the NATO Central Region.

Because of the vast number of interacting variables, including some with multiple data sets which varied significantly, no simulation alone can be considered an accurate predictor of requirements; many simulations are required which test the sensitivity of the results to differences in input variables. This was done to a significant degree in WIMS for a number of reasons: the model was still in development; relative uncertainty as to "right" answers was initially high; the study explored areas not previously examined at this level of detail; and finally, there

were input variables which differed sufficiently to present widely different results. Thus, final base case simulations were always the result of initial bases cases and multiple sensitivity simulations. In some cases, the sensitivity simulation assumptions were incorporated into final base cases. In other cases, the assumptions were considered controversial or significant enough to warrant retention as separate excursions meriting their own discussion and analysis. Final base case assumptions were selected by the study group and do not always reflect those currently in use in DoD for planning or programming.

The other major analysis component was the offline analysis. No mobility computer simulation can be expected to capture every possible movement, particularly intratheater movements. Thus, the offline analysis begun for SWA was intended to complement the simulation and fill in the gaps in subject areas that the simulation could not address. As the study progressed, however, it was discovered that the simulation also enhanced the offline analysis by providing data which made the offline analysis more accurate. As the evaluation continued through the Pacific and NATO theaters, the amount of workload calculated offline was eventually reduced to a minimum as the offline methodologies were integrated into the simulations.

Additionally, in each theater, certain aspects of the mode selection logic were varied, as were certain key parameters (e.g., airfield capacity). Where shortfalls exist, the study also examined several types of issues that bear on the question of how much of the shortfall should be eliminated through additional procurement. The types of issues examined include:

- accepting the risk of not meeting sustainment requirements for a few days during peak activity (thus forcing the draw-down of safety level stocks);

- accepting the risk of diverting intertheater lift to operate intratheater for a short period of time; and

- relaxing certain scenario assumptions of war game-derived requirements.

Throughout this analysis process, the goal was to arrive at a well-defined range in various requirements which could be compared to the corresponding functional capabilities. Included in the capability statement were known or anticipated HNS contributions. This subject produced some startling results, somewhat controversial, requiring additional study in some cases, but representing the best information available. One point to keep in mind is that the capability statements for each theater are a reflection of the allocation of resources to those theaters in the Services programming documents.

The final step in the analysis process, as well as the first component of the study product, is the combined assessment. In order to dampen the effect of allocation of resources to specific theaters, individual theater base case requirements were combined into single data sets and compared with calculated worldwide capabilities. Recognizing that different combinations of sensitivity simulations from the various theaters would have produced different results, it was determined that combining only one set of data for each theater was the best approach. At the same time, this combined data does mask, to some extent, the magnitude of shortages in capabilities in particular theaters at particular time periods, so that theater-unique data must also be examined to support the conclusions formed.

## 3.2 WIMS MAJOR FINDINGS.

Major findings from the study, as shown in Figure 3-4, will be described next. Because much of this material is associated with specific theaters, War Plans, and capabilities and shortcomings and is thus classified, the following can only be an overview. Readers interested in additional details are referred to the complete WIMS report.

- O WORLDWIDE WORKLOAD DISTRIBUTION
  - OO BY THEATER
  - OO BY MODE
- O RELATIVE CONTRIBUTION OF HNS
- O GENERAL FINDINGS
- O MODE SPECIFIC FINDINGS

Figure 3-4. WIMS Major Findings.

### 3.2.1 Worldwide Workload Distribution.

Extensive breakouts of worldwide intratheater workload requirements are available. As outlined in Figure 3-5, the distributions are arranged by theater and by mode of intratheater transportation. As noted earlier, the four theaters analyzed were NATO Central Region, NATO Flanks, Southwest Asia, and the Pacific. Workload distributions for each of these theaters was shown for dry cargo, POL, and passengers using the workload measures shown in the figure. In a similar manner, worldwide workload distributions were shown by the intratheater transportation modes of unit organic vehicles, highway trucks, sea, air, and rail.

- BY THEATER (NATO CR; NATO FL; SWA; PACIFIC)
  - Dry Cargo (tons; ton-miles)
  - POL (barrels; barrel-miles)
  - Passengers (passengers; passenger-miles)

- BY MODE (ORGANIC; HWY; SEA; AIR; RAIL)
  - Dry Cargo (tons; ton-miles)
  - POL (barrels; barrel-miles)
  - Passengers (passengers; passenger-miles)

Figure 3-5. Worldwide Workload Distribution.

### 3.2.2 Relative Contribution of HNS.

In a manner similar to the preceding section, worldwide distribution of dry cargo and POL for U.S. transportation versus HNS transportation was shown. The various cases considered are outlined in Figure 3-6.

In a more general manner, HNS findings are shown in Figure 3-7. HNS is assumed to meet a large portion of the dry cargo and POL movement needs worldwide, but that share is not uniform between the theaters. Some modes of transportation are totally dependent on HNS, e.g., intratheater sealift and railroad. Although official agreements between the U.S. and host countries was the basis for most of the calculations, some support which was not based on formal agreements was assumed. The end result is a wide variation in the levels of risk which are assumed in the various theaters when compared to the workloads calculated.

- WORLDWIDE DRY CARGO TON-MILE DISTRIBUTION (US vs HNS)
  - Intratheater Sealift
  - Assumed HNS Rail and Highway - No Basis
  - Indirect HNS Rail and Highway
  - Direct HNS Highway
  - US Air
  - US Highway
  - US Organic Movements
- WORLDWIDE POL BARREL-MILE DISTRIBUTION (US vs HNS)
  - Assumed HNS Pipe (On Flanks)
  - Assumed HNS Rail and Highway - No Basis
  - Indirect HNS Rail and Highway
  - Direct HNS Highway
  - US Pipe
  - US Highway

Figure 3-6. HNS Workload Distribution.

**WORLDWIDE, HNS IS ASSUMED TO MEET MORE THAN 40 PERCENT OF THE DRY CARGO AND ALMOST 45 PERCENT OF THE POL MOVEMENT REQUIREMENT**

**A WIDE VARIATION EXISTS BETWEEN LEVELS OF SUPPORT AVAILABLE, OR ASSUMED AVAILABLE, WITHIN THE DIFFERENT THEATERS AND FOR DIFFERENT COMMODITIES**

**SOME MODES REQUIRE 100-PERCENT DEPENDENCE ON HNS**

**ASSUMPTIONS NOT ALWAYS BASED ON AGREEMENTS**

**RESULT IS A WIDE VARIATION IN LEVELS OF RISK ASSUMED WHEN COMPARED TO THE WORKLOADS CALCULATED**

Figure 3-7. HNS Findings.

3.2.3 General Findings.

General findings from the WIMS report are summarized in Figure 3-8.

The calculation of intratheater requirements is complicated by an imprecise split between intertheater and intratheater requirements. Some intratheater tasks were previously included in intertheater requirements and were so treated in WIMS. Others are similar to strategic requirements even though they are technically intratheater. The difficulty is in determining which resources should handle the movements and analyzing the subsequent impact on capability.

Mobility data bases prepared by the Services during POM development are inadequate for intratheater analysis, and may understate strategic movement requirements occurring within a theater. WIMS uncovered many requirements that are suited to intertheater types of systems even though they take place within a theater.

Intratheater simulations require data which some agencies are unable or unwilling to provide. The difficulty is simply a reluctance to make estimates and best guesses five years into the future, yet current data,

**CALCULATION OF INTRATHEATER REQUIREMENTS IS COMPLICATED BY AN IMPRECISE SPLIT BETWEEN INTERTHEATER AND INTRATHEATER**

**SERVICES' MOBILITY DATA BASES ARE INADEQUATE FOR DETAILED INTRATHEATER ANALYSES**

**INTRATHEATER MOBILITY REQUIREMENTS STATEMENTS ARE EXTREMELY DEPENDENT ON THE THEATER CONCEPT OF OPERATIONS**

**CALCULATION OF CAPABILITIES IS COMPLICATED BY WIDELY VARIABLE VEHICLE PRODUCTIVITIES**

**SOME PROGRAMS WITH MOBILITY IMPLICATIONS MAY BE OUT OF SYNCH WITH EXPECTED COMBAT RESULTS**

Figure 3-8. General Findings.

and the operation plans which are predicated on them, reflect constrained capabilities and are generally not the best sources of information to use for the outyear projections routinely used in programming.

Tons per day is not an adequate measure of requirements or capabilities for any mode. At a minimum, the average distance over which cargo is to be moved should be specified and a ton/distance factor used. Since the average movement distance and vehicle payloads vary widely by cargo type, requirements should be displayed by commodity when possible.

Intratheater mobility requirements are extremely dependent on the theater concept of operations. While it is recognized that scenarios create differences in requirements, the wide range in mobility requirements caused by different operational concepts and expected combat results cause questions about the use of standard planning factors alone when making mobility requirements estimates or capability assessments.

3.2.4 Mode Specific Findings.

Mode specific findings from the WIMS report are summarized in Figure 3-9.

The potential contribution to unit movement requirements afforded by units moving themselves is potentially greater than expected. In the base case, organic movements account for 1/3 of the total tons lifted, all commodities, worldwide, and 1/5 of the ton-miles work load. In the NATO CR the contribution is even greater, accounting for almost half of the tons moved and 1/4 of the workload generated. The potential for employing organic vehicles in shuttle operations when units displace provides even greater potential resources than those measured in WIMS which assumed only a single lift per day for each organic vehicle.

Highway movements in some scenarios yield much lower vehicle productivities than doctrinally described. Long distance line haul movements with trailer transfer operations, which doctrine describes, were not evident. Requirements for short movements at the end of the distribution system suggest that a force structure with additional light

ORGANIC MOVES

- POTENTIAL CONTRIBUTION OF UNITS MOVING THEMSELVES NOT PREVIOUSLY QUANTIFIED
- ACCOUNTED FOR 1/3 OF TOTAL TONS LIFTED WORLDWIDE, ALMOST HALF IN NATO
- POTENTIAL CONTRIBUTION EVEN GREATER WITH SHUTTLE OPERATIONS

HIGHWAY DRY CARGO

- U.S. FORCE STRUCTURE OUT OF BALANCE WITH THE WORKLOAD DESCRIBED IN WIMS
- WORKLOADS MAY BE MORE VEHICLE-INTENSIVE THAN TONNAGE OR DISTANCE INTENSIVE

HEAVY EQUIPMENT TRANSPORTERS (HETS)

INTRATHEATER AIRLIFT

- AIRFIELD CONGESTION LIMITED THE POTENTIAL CONTRIBUTION OF AIRLIFT
- INTRATHEATER AIRLIFT SHORTFALL CANNOT BE PRECISELY DETERMINED WITHOUT CONSIDERATION OF POTENTIAL CONTRIBUTIONS OF THE INTERTHEATER FLEET

PETROLEUM MODE REQUIREMENTS

- STRATEGIC AIRLIFTER REFUELING POLICY DRAMATICALLY CHANGES THE ANALYSIS
- WHERE AVAILABLE, PIPELINES USED TO CAPACITY BEFORE OTHER MODES

PASSENGER MOVEMENT

Figure 3-9. Mode Specific Findings.

and light-medium truck companies and fewer line haul medium truck companies would provide a more balanced fleet capability. Recognizing that the unit productivity measured in tons delivered per force structure space is much higher in a medium truck company than in the other two, the difficulty is delivery requirements may be to locations which the larger vehicles cannot reach.

Heavy Equipment Transporters (HETs) are required in large numbers if surface relocations of armored units occur over long distances and no rail is available, or if self-deployment is limited. The vast majority of movement requirements measured suggests that, over the distances involved, self-deployment is an acceptable mode. It is difficult to accurately determine the HET capability, considering the doctrinal disconnect between the functional requirement for HETs (maintenance support versus transportation).

Airfield congestion limits the potential contribution of airlift. Increasing the capacity of available airfields or assuming the ability of aircraft to operate out of unimproved locations was demonstrated to significantly increase the potential contribution of airlift. Intra-theater airlift shortfalls worldwide cannot be precisely determined without consideration of potential contributions of the intertheater fleets. In every theater, events are expected to occur which exceed the capability of the intratheater fleet. In some cases, the origin and destination airfields are capable of handling strategic airlifters and these missions could be included in intertheater airlift requirements; recognition must be given to the significantly lower productivity of intertheater aircraft used for intratheater missions.

The storage and replenishment of jet fuel in-theater may affect requirements for other modes which move the POL. A policy for refueling intertheater airlifters needs to be established for programming purposes. Where available, pipelines are used to capacity before other modes are employed to move POL.

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# CHAPTER 4

# WIMS DATABASE DEVELOPMENT AND USE

by COL Michael D. McManus, USA

ABSTRACT: This presentation details the development and use of the WIMS database. The magnitude of the problem is described, and methodology developed to solve specific problems, including: a more accurate computation of consumption; different Line of Communication strategies; dynamic force deployments and redeployments in opposite directions; Southwest Asia water distribution, which examined the trade-off between water production and transportation force structure; and the difficulties in describing and calculating airlift requirements.

## 4.0 PRESENTATION OUTLINE.

I - Database Development

II - Resupplying the Force

III - Water Distribution

IV - Building the Airlift Requirement

## 4.1 DATABASE DEVELOPMENT.

The significant challenges involved in the development of the WIMS database were a function of the magnitude of the problem, the need to develop an appropriate tactical transportation simulation, and the dynamics of force deployments and redeployments. Those elements will be described in this section followed by some examples in subsequent sections of methodologies developed to solve specific problems.

The magnitude of the problem is evident from the numbers shown in Figure 4-1. For the base case simulations, that huge number of movements involving the units and tonnage indicated is a staggering challenge.

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Ed: Much of this presentation was classified SECRET. The classified material has been summarized in this paper so that the TACTRAN report may remain unclassified. This presentation was based on information contained in the WIMS Final Report (dated February 14, 1988). A complete copy of that report may be obtained from OSD(PA&E).

**GEE WHIZ FRONT-END NUMBERS**
**BASE-CASE SIMULATIONS**

**92,912 MOVEMENTS CALCULATED/ANALYZED**

**24,521 SEPARATE UNITS IN SERVICES' DATA BASES**

**7,253,892 TONS OF UNIT EQUIPMENT INVOLVED**

Figure 4-1. Magnitude Of The WIMS Problem.

The composition of WIMS movements is illustrated in Figure 4-2. For example, 46.6% of the total movements for the base case simulations are in the NATO Central Region. Of that quantity, 23,232 different moves are for unit equipment (UE). Finally, the source of those UE moves is shown as a distribution of FLOT movements, strategic movements (from MIDAS model), movements from marshalling areas (e.g., POMCUS sites), and manually input by the analysts.

Another way to consider the magnitude of the WIMS problem is by considering NATO. Because the NATO Central Region has been extensively studied, a great deal of material is available. This in itself compounds the difficulty in doing an intratheater mobility analysis due to the following considerations: capabilities assessments produce results that differ from requirements studies; scenario-driven variables and assumptions produce, in some cases, dramatically different answers; projections on the status of programs affecting mobility requirements vary; despite years of study, doctrine is unclear in some areas; and finally, the volume of data required to perform simulations in this theater is enormous, leading to some data driven errors. The problem can be summarized in Figure 4-3.

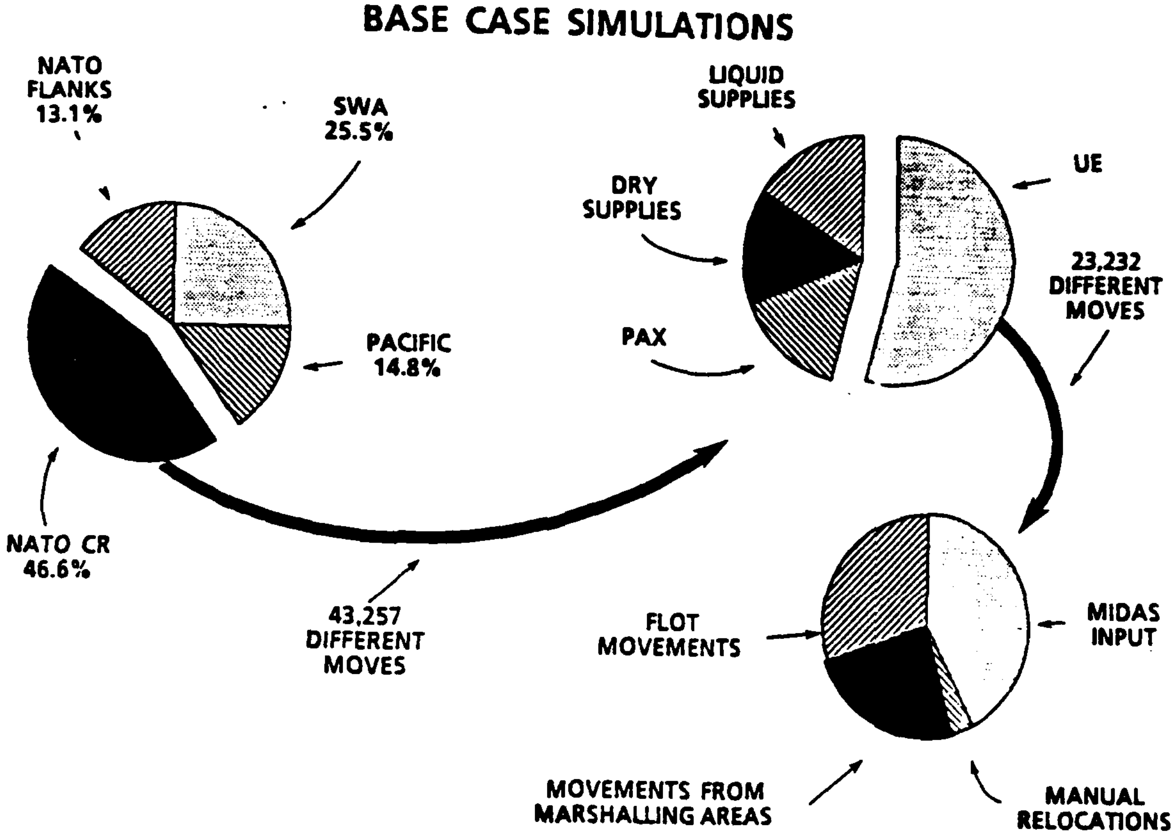



Figure 4-2. WIMS Movements Composition.

- O 4800 ARMY UNITS TO 90 DESTINATIONS IN 11 COUNTRIES
- O 9000 USAF UNITS TO 260 DESTINATIONS IN 13 COUNTRIES
- O 27 MAJOR USMC UNITS TO 3 DESTINATIONS IN 3 COUNTRIES
- O RELOCATIONS OF IN-PLACE / POMCUS UNITS PRIOR TO D-DAY
- O MOVEMENTS IN OPPOSING DIRECTIONS
- O LATE ARRIVALS OF FOLLOW-ON FORCES
- O RELOCATIONS OF PREDISTRIBUTED STOCKS
- O SERVICE UNIQUE LOGISTICS SYSTEMS
- O HEAVY ALLIED USE OF INFRASTRUCTURE

Figure 4-3. The NATO Problem Summarized.

Those large movement requirements are illustrated in Figure 4-4 which shows the numbers of links and nodes required to represent the network for each of the four scenarios.

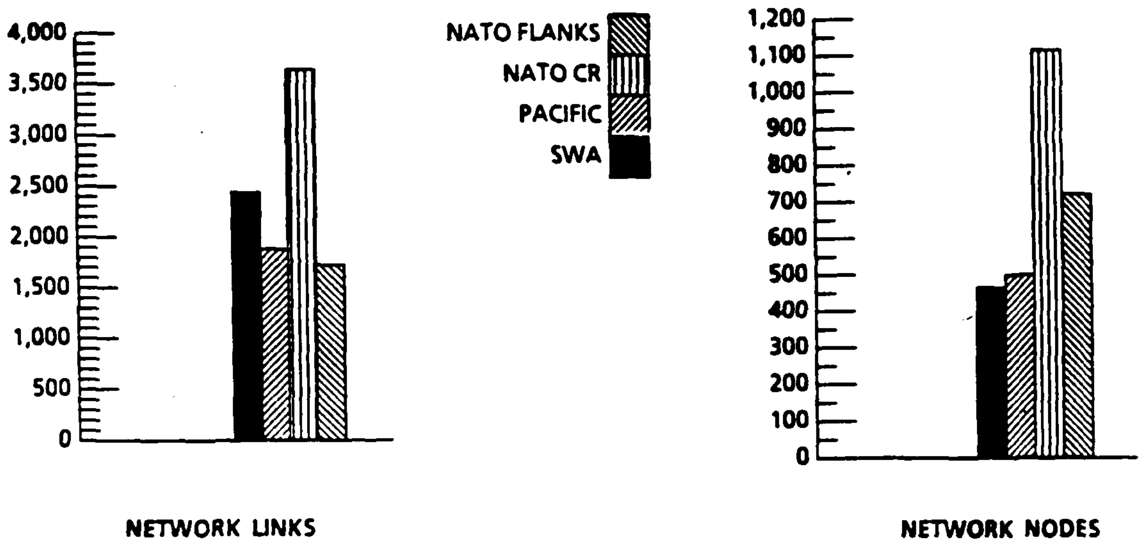



Figure 4-4. SUMMITS Networks.

Finally, Figure 4-5 presents key indicators of the WIMS magnitude. Over 200 total runs of SUMMITS were required with almost half of those required for development of the model and scenarios. More than 1,750 CPU hours were required, exclusive of MIDAS runs, to complete the analysis, and these produced more than 40,000 pages of output data and graphs.

In addition to the magnitude of the problem just described, a significant challenge remained to build a model capable of simulating intratheater movements while the analysis was already underway. As outlined in Figure 4-6, SUMMITS remained under development during most of the actual production analysis. The five concepts identified in the figure were developed independently from the simulation and analyzed off-line. Only in the latter stages of the study were these off-line results input to the simulation. In addition, the SWA and Pacific scenarios were rerun in the final version of SUMMITS in order to smooth out differences caused by using an evolving model.

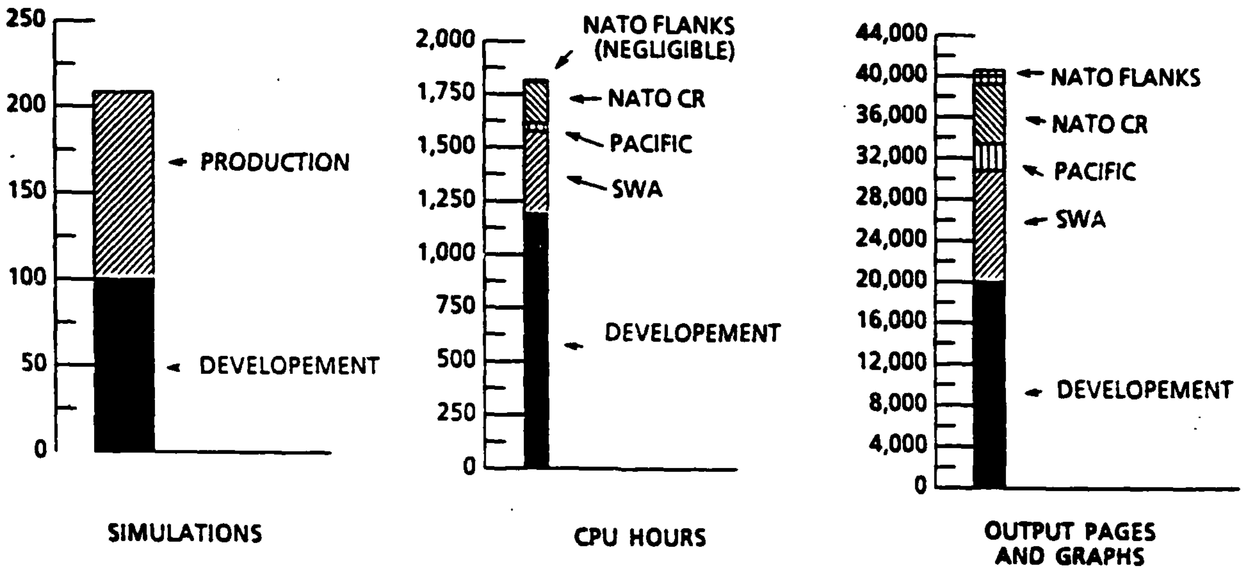



Figure 4-5. SUMMITS Simulation Numbers.

**SUMMITS A DEVELOPMENTAL MODEL THROUGH THE NATO SIMULATIONS**

**CONCEPTS DEVELOPED INDEPENDENTLY; ANALYZED INITIALLY BOTH OFFLINE AND IN SIMULATION. EVENTUAL INCLUSION OF OFFLINE IN SIMULATION**

- **AIRLIFT REQUIREMENTS**
- **WATER**
- **ATTRITION**
- **LOGISTICS SYSTEMS**
- **FLOT MOVEMENT**

**REVISITED SWA AND PACIFIC AFTER FINAL MODEL ENHANCEMENTS**

Figure 4-6. Building The Model.

One of the difficult challenges in WIMS involved the dynamics of force deployments and redeployments, particularly in the NATO Central Region. The concept of operations used in the wargame versus the initial force deployments caused simultaneous movements in both directions. This caused difficulty because the node assignments for initial force beddown may have closed by the time the unit arrived. In addition, the relocation of some units displaced other units to nodes in the rear that were designated as initial destinations for other units. As units were relocated, nodes and network segments were closed. Some network saturations occurred in high activity regions. The timing of node closures required anticipating the arrival of the FLOT in order to ensure adequate time in which to relocate.

Figure 4-7 outlines some of the modeling techniques used to meet the challenge of dynamic force movements. As indicated, nodes were linked with additional information, collocated nodes were allowed, and relocation dates and node closure dates were separated.

- **NODE ASSOCIATION LIST LINKED:**
  - **FORCE DESTINATION NODES WITH ALTERNATE NODES**
  - **TIMING OF NODE CLOSURES**
  - **SHOWED ATTRITION OF RELOCATING FORCE**
- **COLLOCATED NODES ALLOWED:**
  - **SUPPORT FORCES TO RELOCATE FROM CLOSING NODES**
  - **COMBAT FORCES TO OCCUPY SAME NODE**
- **RELOCATION DATES AND NODE CLOSURE DATES WERE SEPARATE**
  - **ALLOWED PHASED RELOCATION OF UNITS TO PREVENT NETWORK SATURATION**

Figure 4-7. Dynamic Force Modeling Techniques.

## 4.2 RESUPPLYING THE FORCE.

The remaining sections present examples of methodologies which were developed in WIMS to solve specific problems.

It was important to the success of this analysis that more accurate means be determined in which to portray consumption by the theater force. The methodology needed to be sensitive to changes caused by attrition of the force, to the varying combat intensity at each node, and to differences in consumption among different type units. It also needed to reflect the reality of Service-unique logistics structure.

Theater resupply stocks are distributed to depots, forward storage areas, and destinations. The methodology needed to be capable of examining alternative resupply lines of communication (LOC) strategies.

In addition, force relocations resulting from the combat scenario caused dynamic adjustments to occur within the supply system which the methodology had to accommodate. Some stocks had to be retrograded to avoid loss while others were transferred laterally to meet shortages at other supply points. These dynamics also caused unit sources of supply to change at times.

Overall, the WIMS consumption methodology calculated resupply requirements which were lower than those calculated in some other studies. This observation is particularly evident for analyses which utilize Army Force Planning Data and Assumptions (AFPDA) theater average rates to calculate total consumption. The conclusion is clear that the application of theater average rates (e.g., AFPDA values) is not useful in intratheater simulations. They possibly overstate the total requirement, but they clearly lead to distortion of the intratheater movement requirements.

4.3 WATER DISTRIBUTION.

In SWA, unique when compared to the rest of the world, water is a critical, not readily available commodity. The need exists for a logistical network whose function is detection of water sources, drilling, purification, storage, and distribution of water.

A central issue in determining the transportation requirement was the question of water source locations. A trade-off clearly exists between the force structure and operational implications of adding additional production and storage capacity versus adding additional transportation.

A related question is the shortfall in consuming units' ability to carry sufficient water with organic resources. In the simulations, units located at nodes where production facilities existed were assumed to pick up their own water. If water was moved from adjacent nodes, it was assumed common-user transportation moved the water to either a General Support or Direct Support facility, which still left units the responsibility to pick up their own water.

Common-user airlift was not used for the movement of water in the simulations. The production facilities were generally located close enough to the majority of consumers to insure that most water distribution occurred from water points to consumers on organic transportation. That is not to say that airlift would never be used for the movement of water; airlift could and most likely would be used in emergency resupply operations for limited periods of time resupplying isolated units.

The WIMS Main Report focused only on mobility requirements. However, a considerable amount of additional information was developed and documented in one of the Appendices. The appendix is a summary of key data and analysis elements developed in the study to include: assumptions, consumption factors, concept of operations, environmental influences, force structure summary, WIMS SWA force destination/water source pairs, and maximum water production compared with maximum demand.

4.4 BUILDING THE AIRLIFT REQUIREMENT.

The NATO Central Region presented the most obvious example of the difficulties encountered in sizing airlift requirements. This theater, with very large movement requirements, also had many mode alternatives to airlift, and considerable effort was expended exploring the "proper" allocation of workload to airlift. The following briefly describes that process.

The SUMMITS model was purposely built to make mode selections independent of analyst determined mode input. Thus, for example, the selection of airlift to make unit moves or move supplies was intended to be a function of the air mode competing with surface modes, consistent with the available infrastructure capacities, cargo characteristics, and other variables which affect mode selection, with speed of delivery in relation to RDDs the principal determining factor. The model logic has been modified to overcome the inherent bias toward airlift when deliveries can be made within a day of their RDDs, regardless of the fastest delivery mode. Also, while there are many movements worldwide where airlift is selected as the preferred mode, there is also a bias toward surface moves that occur over short distances when surface modes are available. Specific missions were examined with offline analysis providing the basis for designating airlift as the preferred mode rather than the simulation.

The workload to evacuate patients within the theater was derived from several sources. In WIMS, the assumption was that patients would be moved by either helicopter or surface to centralized facilities for further evacuation by air.

An assumption was made that 5% of the cargo arriving in the theater by intertheater aircraft would land at other than intended destination airfields. The reasons were many: combat operations temporarily closing destination airfields, weather, maintenance problems, etc. It was further assumed that the additional movement would be picked up by intratheater aircraft rather than by the intertheater aircraft, so the requirement was in addition to other intratheater workloads rather than being a degradation of the intertheater fleets.

A simple calculation was made based on perceived numbers of aircraft providing channel mission service to various customers each day.

In the turbulence associated with the moving FLOT, some air bases with operating Air Force units had to be evacuated. In addition to unit relocations, a decision was made to move the remaining munitions as well.

The concept of operations described emergency resupply requirements in addition to normal consumption for many different units at different intervals. Some of those requirements were satisfied by surface; most were perceived as airlift missions and were moved by air. Subsequent to the development of the concept of operations, during preliminary base case development, it was determined that for Army units, rather than have a collection of random units being resupplied by air, it was simpler to assume an aerial resupply requirement for different sized organizations.

Given an area of operations where virtually every Army unit deployed is relocated at least once in the first 30 days, determining how many must move by air is a challenge. Sensitivity simulations were made to measure the daily impact of attempting to move various sized organizations. The most obvious observation was that moving Army units of any operationally significant size required more effort than accomplishing all the other missions combined. Moving a brigade-sized organization on a daily basis proved to be infeasible due to airfield constraints. The number of sorties required generally could not be absorbed by any single airfield in the divisional areas. Splitting the workload among more than one airfield creates additional difficulties as units must move increasingly longer distances to find airfields with available capacity. At some point, it simply becomes quicker and easier to continue the relocation on the surface rather than make the investment in time necessary to organize for airlift operations.

CHAPTER 5

# TACTICAL MOBILITY - AN AIRLIFT PERSPECTIVE

by COL Alexander P. Shine, USA

ABSTRACT: This presentation initially discusses a philosophy of analysis from the perspective of the decision maker. Recognizing that like himself, many decision makers have relatively limited understanding of qualitative analysis, COL Shine suggests ways to focus analysis so that it gives the decision maker the information that will both clarify for him what the decision points are, and give him a proper basis for making the decisions.

The remainder of the presentation focuses on theater airlift. First, it compares airlift to other means of transportation, then discusses more specifically how airlift can be employed to enhance combat effectiveness, particularly at the operational level of war. With this foundation, some areas for fruitful analysis of theater airlift are suggested, to include some specific issues which require continued analysis, and measures of effectiveness for theater airlift.

## 5.0 PRESENTATION OUTLINE.

I - Philosophy: Analysis for Decision Makers

II - Airlift Vice Ground Transportation

III - Employment of Theater Airlift

IV - Analysis of Theater Airlift

## 5.1 PHILOSOPHY: ANALYSIS FOR DECISION MAKERS.

When I took this job, I didn't know much about analysis. COL McManus' predecessor looked forward to my help with WIMS, but it didn't take him long to realize that it would be awhile before ACRA could be much help to him. I have now learned enough to be dangerous. I now know:

- what "on-line" and "off-line" is,
- a "model" is not something you put together with airplane glue,
- the difference between a "stochastic" and "deterministic" model (if I look at my notes), and
- the "Delphi Method of Analysis" is a fancy term for a group WAG.

With the kind of analytical background I have just described, I am typical of your customers, the decision makers who look to you for help. You have to be able to sell your services to guys like me; then explain the results in ways we can understand and use.

The key points in selling services are shown in Figure 5-1. They are fairly obvious, but important. The key problem is often that the customer doesn't know enough about the situation and your capability to ask for help. You help both parties by asking for what the customer wants and in a way that you can answer. In order to do that,

(1) Know or learn the customer's needs. Figure out what questions he needs answered.

(2) Show that you can provide answers. Present a layman's overview of the methodology. Convince him that the answers will be credible.

(3) Interact with him to formulate the questions. The questions, in turn, become your tasking.

(4) Give him an upfront description of what the results will be, e.g., various options to meet shortfalls or comparative costs of each action.

- **KNOW CUSTOMERS NEEDS**
- **BELIEVABLE ANSWERS TO HARD QUESTIONS**
- **INTERACTIVE FORMULATION OF QUESTIONS**
- **CLEAR DESCRIPTION OF PROJECTED RESULTS**

Figure 5-1. Selling Services.

A philosophy for presenting results is shown in Figure 5-2. Be results oriented. Tell upfront what you found out without dwelling on methodology.

Identify the decision points clearly. For example, if it is clear that I need a capability to move tanks, don't ask me if I need to include jeeps in the decision. Show the key cost benefit tradeoffs. Show where the cost-benefit curve bends, and why. For example, the WIMS study shows a major increase in airlift requirements to move heavy units. We need to decide how important it is to meet that requirement.

- RESULTS ORIENTED
- IDENTIFY DECISION POINTS
  - -- KEY COST BENEFIT TRADEOFFS
- ESCHEW HARD ANSWERS BASED ON SOFT DATA
  - -- IDENTIFY ASSUMPTIONS
  - -- IDENTIFY HARD VICE SOFT DATA
  - -- DON'T DO WHAT YOU CAN'T DO

Figure 5-2. Presenting Results.

Eschew hard answers based on soft data. Be sure that I know your key assumptions. Be honest about data which is mathematically hard as opposed to that where there are many subjective decisions (made off-line or on-line) involved. For example, the calculations for survivability of an aircraft if it is hit by a given munition should be hard, but the calculations for the probability of hitting an aircraft in flight with a given weapon is a lot softer.

Finally, don't try to do what analysis can't do, i.e., don't try to weigh comparative values of unlike factors. For example, the Running Back Weighted Value formula in Figure 5-3 looks impressive, but I doubt if Joe Gibbs will ever use it to rank his draft choices.

$$\text{WEIGHT} \div 200 = X$$

$$\text{SPEED} \div 4.0 = Y$$

$$\text{AGILITY} \div \text{WALTER PAYTON} = Z$$

$$X(.2) + Y(.67) + Z(.21) = \text{RUNNING BACK WEIGHTED VALUE (RBWV)}$$

Figure 5-3. Running Back Evaluation Formula.

In the same manner for airlift, a weighted value such as illustrated in Figure 5-4 does not help the decision maker. Instead, show the decision makers comparisons in each area, and let them decide which is the most important factor.

$$\left.\begin{array}{ll} \text{PAYLOAD} & \times\ a \\ \quad + & \\ \text{SPEED} & \times\ b \\ \quad + & \\ \text{SURVIVABILITY} & \times\ c \\ \quad + & \\ \text{STOLness} & \times\ d \end{array}\right\rangle \neq \text{AAWV}$$

Figure 5-4. Airlift Aircraft Weighted Value (AAWV).

## 5.2 AIRLIFT VICE GROUND TRANSPORTATION.

Now I will shift gears from something I know almost nothing about to something I know at least a little bit about, theater airlift.

First, what are it's advantages and disadvantages in comparison with ground modes. This may seem like a basic question with an obvious answer, but, like most basic questions, it is a critical starting point, especially for any comparative analysis. The bottom line is that we ought to use the best and most efficient means for each task.

Figure 5-5 lists the three main advantages of airlift in order of importance for theater airlift (realizing that speed is the most important factor for strategic airlift).

- **FLEXIBILITY**
- **RESPONSIVENESS**
- **SPEED**

Figure 5-5. Advantages of Airlift.

Flexibility of airlift comes from not being tied to ground lines of communication (GLOC). Airlift can deliver its cargo anywhere with airdrop or sling load and close to anywhere with airland delivery. It is not subject to LOC interdiction or degradation. Also it is easier and quicker to build an airstrip than a major road, railroad, or canal.

Theater airlift is exceptionally responsive. When it is needed, you can send it where you want to get a job done. This feature is very important for unplanned, short-fuze movements.

Finally, speed of theater airlift compared to surface modes is more significant as the distance to travel increases.

WIMS illustrated all three of these advantages. The difficulty with GLOCs in South West Asia (SWA) showed the advantage of airlift flexibility. The responsiveness in moving a heavy division in SWA was key to success. It is both cheaper and more realistic to pull airlift from the strategic flow and concentrate them for a surge requirement than to base larger numbers of Heavy Equipment Transporters (HETs) in-theater hoping they will be where they are needed when they are needed. Finally, the "x-rule" showed the advantage of speed. The rule states that if the delivery will be late and airlift is quicker by "x days", then choose airlift.

The disadvantages of theater airlift are shown in Figure 5-6. The obviously biggest disadvantage is cost. Aircraft are very expensive to purchase compared to other alternatives, and they are also very expensive to operate.

- **COST**

- **"NON - DIRECT" DELIVERY (AIRLAND)**
- **WEATHER**
- **THREAT LIMITED?**
- **AIRFIELD AVAILABILITY / CAPACITY LIMITED?**

Figure 5-6. Disadvantages of Airlift.

In general, airland operations are less direct delivery than trucks, may or may not be more direct than railroads, and are usually more direct than water modes. This is a particular problem for light forces which don't have many integral vehicles to transship loads to their final destination.

Airlift is somewhat limited by weather, but this is becoming less and less of a problem. There are even weather conditions, such as snow, where aircraft are better than surface modes of transportation.

The limitations posed by the threat depend on the situation. Sometimes, such as Vietnam and Afghanistan (see the article in the January 1988 Army Magazine), airlift is safer than surface transportation. Many other times, ground movement is safer than air. The general rule is that the closer the movement is to the FLOT, the more problems there are to airlift.

The availability of airfields and their limited capacity can be a serious problem for airlift, but again it depends on the situation. In some places, such as Vietnam and some areas of SWA, there are more airfields than there are decent roads. However, in general there is more ground movement capacity than there is airfield capacity. This problem for airlift decreases with a vertical lift capability. Airdrop almost eliminates the problem, but it does require an airdrop system and considerable rigging time, and successful completion can be tricky.

In summary, use theater airlift to gain flexibility, responsiveness, and speed. However, as shown in WIMS, don't use theater airlift if ground modes can do the job better.

## 5.3 EMPLOYMENT OF THEATER AIRLIFT.

Now a few words about how theater airlift is used and what it does. The bottom line is that it does what every transportation asset does. It moves people and things. However, especially with airlift, what type mission the transportation asset is doing may affect significantly how it operates.

Figure 5-7 lists what we call the five "Mission Categories" for USAF theater airlift. Army airlift might add a sixth category, "Air Assault", as a specialized form of employment.

- **DEPLOYMENT**
- **EMPLOYMENT**
- **SUSTAINMENT**
- **RETROGRADE**
- **AIR EVACUATION**
- **OTHER**

Figure 5-7. Theater Airlift Mission Categories.

The deployment mission entails getting forces to their initial area of operations in theater. Theater deployment moves them forward from seaports, air main operating bases, or staging bases. Shifting around of prepositioned equipment can be a big part of this requirement.

The employment mission involves moving forces around in-theater after the completion of deployment. Be careful not to forget the Air Force requirements. They are a big customer of employment.

The sustainment mission refers to the movement of replacement personnel and of supplies such as bulk cargo and POL.

The retrograde mission involves movements on the return of deployment, employment, or sustainment missions. The largest users of retrograde airlift are non-combatant evacuees and enemy prisoners of war. Equipment will also be retrograded for needed repairs.

Air evacuation is a specialized form of retrograde movement, but it needs to be highlighted as a separate mission because it requires a specially configured aircraft.

"Other" missions are non-airlift missions flown by airlift aircraft, to include: recon; air refueling; fire support; flare and leaflet drops; and C3. Additionally, airlift aircraft are used in support of special operations forces (SOF) as a specialized form of the normal airlift mission categories.

However, the category descriptions alone are not very helpful in understanding airlift requirements. As illustrated in Figure 5-8, what is needed is an understanding of what the airlift mission is doing, i.e., answering the following questions. What is the cargo? Where will it be delivered? What support is required?

The deployment and employment missions primarily carry personnel and rolling stock with comparatively little bulk cargo. The aircraft configuration for this mission is important. The weight and size of equipment is a key concern, but there is comparatively little concern about material handling equipment (MHE). The delivery location can impact requirements since it needs to be delivered as close to the final destination as possible, but usually not directly into range of enemy weapons, such as artillery, with the possible exception of airdrop missions.

The sustainment mission primarily involves delivery of bulk cargo. Key issues impacting requirements include how the cargo is rigged and loaded, how it is unloaded (MHE needs), and what the receiver does with it

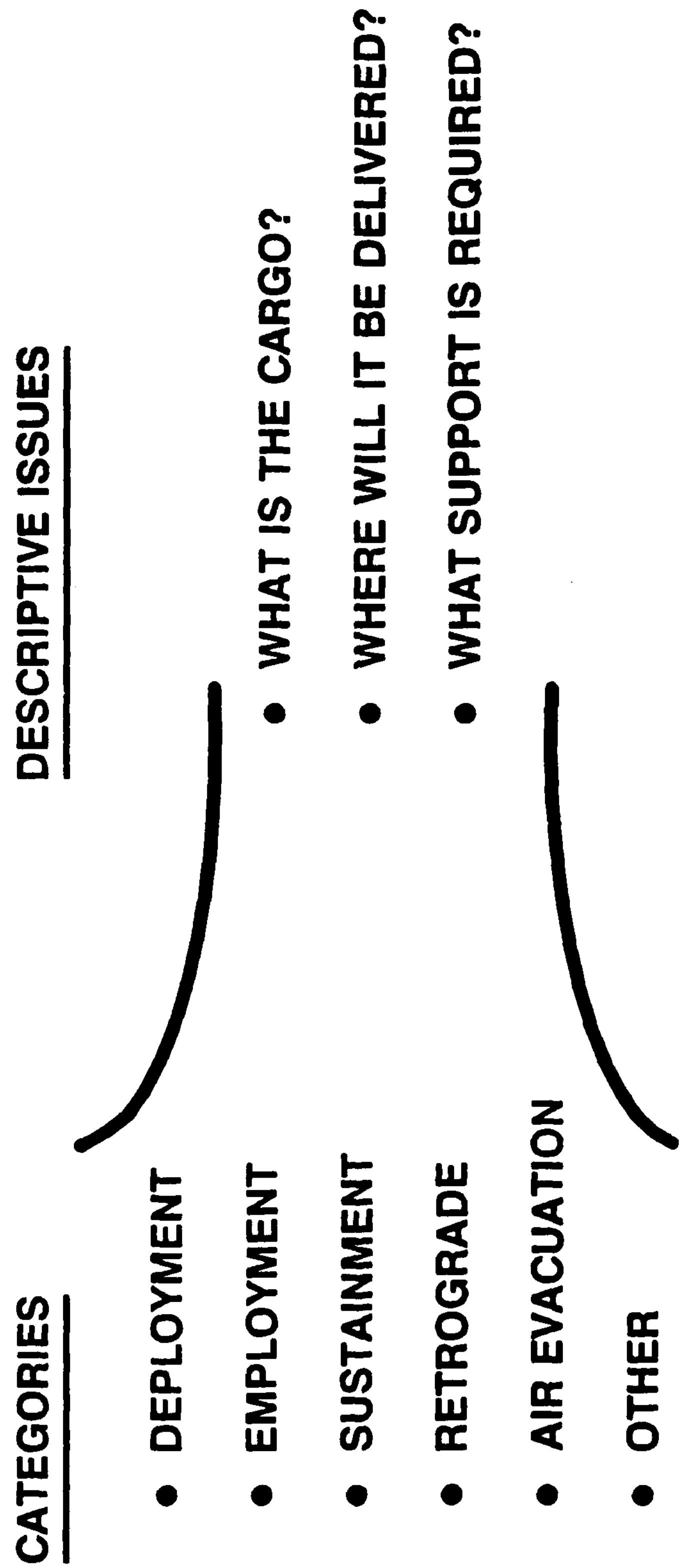



Figure 5-8. Theater Airlift Mission Category Details.

when he gets it. How low organizationally (corps, division, brigade, battalion, company) the cargo will be delivered can be a major determinant of requirements, since the airlifter may need to go close to or even across the FLOT where air and ground threats are a concern.

The C-17 direct delivery capability illustrates this issue. Deployment and employment delivery is to be as close to the final destination as possible, but outside of the enemy threat. Delivery of sustainment missions may be to corps, division, or brigade level primarily driven by the problem of supply management and distribution, but it could mean delivery into a threat environment.

The retrograde mission could create problems in aircraft configuration or in scheduling.

The air evacuation mission requires a specialized aircraft and crew. Floor loading may be acceptable in emergencies, but in general it turns WIAs into KIAs and needs to be avoided.

In summary, the basic idea is that the different mission categories have different concerns. In the analysis of airlift requirements, we may need to separate the requirements into those mission categories. It is important to get the decision makers to decide on the decision drivers, namely, what mission categories are of primary importance to them.

## 5.4 ANALYSIS OF THEATER AIRLIFT.

The last section of this presentation deals with analysis of theater airlift; more specifically, a discussion of where we need more or better analysis, and measures of effectiveness. I will divide the discussion about where we need more or better analysis into two parts - current and programmed aircraft, and future systems.

We have two and maybe three new airlift systems programmed for fielding in the 1990s - the C-17, V-22, and C-27. To a greater or lesser degree, we are trying to figure out exactly how to use these new airlift systems. Let me suggest some analytical efforts that may help.

Figure 5-9 outlines some key points for the C-17. First, note that strategic direct delivery deployment for the C-17 is theater and OPLAN or scenario oriented. We need to show the possibilities for improvement in delivery time, and reductions in intratheater movement requirements. That analysis needs to include the management of port requirements. The payoff for this analysis, in addition to the good public relations from visibly showing benefits of the C-17, is when theater planners begin to think through how they can benefit for the new capability. A good example of this analysis is the article, "The C-17 in an Iran Scenario: A Perspective Beyond 66-Million Ton-Miles per Day," by Lt. Col. J. David Patterson in the January 1988 issue of Armed Forces Journal.

Employment missions for the C-17 are also scenario oriented. Their purpose is to use airlift to move units in order to win wars. A lot of work has been done in this area recently, notably studies by LTV in support of the C-17 and by Vector Research in support of Lockheed's analysis of tactical transportation requirements (see Dr. Bonder's presentation following).

Areas for more or better study include creating new scenarios of interest other than Central Europe and SWA. For example, NATO flanks, Middle East, and SOUTHCOM offer possibilities. Don't just focus on moving heavy units or light infantry. Consider also the movement requirements for such units as a motorized division, airborne division, air assault

STRATEGIC DIRECT DELIVERY DEPLOYMENT

- THEATER / SCENARIO ORIENTED
- IMPROVEMENTS IN SPEED
- REDUCTION OF THEATER MOVEMENT REQUIREMENTS

EMPLOYMENT

- MANY SCENARIOS
- MOTORIZED, AIRBORNE, AIR ASSAULT, MAGTF'S
- COMBAT SUPPORT UNITS
- AIR FORCE - MIX AIR AND GROUND

STRATEGIC DIRECT DELIVERY SUSTAINMENT

- TO CORPS, DIVISION, OR BRIGADE?

Figure 5-9. C-17 Analysis Opportunities.

division (maybe with their helicopters self deploying), and a Marine MAGTF. Consider the use of combat support elements moved independently of combat maneuver units as force multipliers at the operational level of war, for example, field artillery, air defense artillery, and engineers. Finally, consider Air Force unit moves and the requirements for rapid runway repair.

Another consideration is to make sure the movements are realistic. Don't make pure C-17 moves, or even pure airlift moves. Just as was done in WIMS, some mixture of airlift and ground transportation is the most probable way of moving a heavy unit and the analysis must reflect that reasonableness. Just as before for deployment, the payoff for this analysis, in addition to good public relations material, is its help to us in thinking through how to most effectively use this new capability.

Finally, strategic direct delivery for sustainment of forces is an area where we need the most help, and where the Army's TRADOC is currently involved. The basic question is to evaluate the cost-benefit tradeoffs of strategic direct delivery to the corps, division, or brigade level. Analysts need to work with logisticians, including supply managers and transportation managers, to determine what would be the likely candidate loads, the savings in time and theater transport, and the costs in materiel handling and management for each of these delivery options. This analysis is important to help determine how to adjust the supply and transportation system to best use the capability of direct delivery.

Figure 5-10 outlines some key points of analysis for the Army V-22. A capability and cost comparison of the V-22 is needed with systems which operate in the same general area, i.e., the CH-47, UH-60, C-27, and C-130. What exactly does the V-22 do best? What types of missions is it best capable of performing (e.g., MEDEVAC), and what payloads can it best carry? Illustrative scenarios are needed for all theaters of interest. Such an analysis will help us determine the most cost effective use of the V-22 and help determine an efficient tradeoff with the CH-47s or UH-60s.

- **CAPABILITIES AND COST COMPARISON WITH**
  - **CH-47D**
  - **UH-60**
  - **NOTIONAL C-27**
  - **C-130**
- **ILLUSTRATIVE SCENARIOS**

Figure 5-10. Army V-22 Analysis Opportunities.

Figure 5-11 outlines some analysis opportunities for the C-27 airplane. The C-27 is an Air Force program to quickly field a small load, STOL aircraft to fill the gap between helicopters and the C-130 in response to a ROC from USSOUTHCOM. The same basic analytical needs exist for the C-27 as discussed just above for the V-22 (i.e., a capability and cost comparison with the C-130, V-22, and CH-47D). Illustrative scenarios are needed that focus on contingency theaters (for example, SOUTHCOM, Africa, and PACOM), although there is a need to also show its possible value in major theaters such as EUCOM and SWA (just as there is a need to show the Light Infantry Division's value). These analyses are needed to help confirm the requirement and to refine specific requirements about what capabilities the aircraft really needs.

- **CAPABILITIES AND COST COMPARISON WITH**
  - **-- C-130**
  - **-- V-22**
  - **-- CH-47D**
- **ILLUSTRATIVE SCENARIOS**
  - **-- SOUTHCOM**
  - **-- PACOM**
  - **-- AFRICA**
  - **-- EUCOM AND SWA**

Figure 5-11. C-27 Analysis Opportunities.

Future theater airlift is an exciting area for analysis. Until now, I've been suggesting areas where analysis can help us make small decisions and fine tune big ones. However, when we look at 21st Century theater airlift, analysis should be a key player in helping us make big decisions. For example, what aircraft should we buy for the year 2000 and beyond? Two specific examples are the Army Advanced Cargo Aircraft (ACA), a supplement or replacement for the CH-47, and the Air Force Advanced Tactical Transport (ATT) which is a upplement or replacement for the C-130. I won't dwell much here beca Lud Vukmir, ASD, and Dr. Seth

Bonder, Vector Research, will talk later here about excellent work already being done in these areas. (Ed: see Chapters 10 and 12, respectively).

There isn't much I am going to suggest here which they aren't already doing, but I do have four comments. First, our interest is in the future theater airlift fleet, not a future theater airlift aircraft. An ATT or ACA must have a logical, cost effective role which compliments and doesn't duplicate the roles of other airlifters. Consider it a DoD fleet, and then break it down by Service. Figure 5-12 shows some possible mixes for that fleet. The (-) notation with the C-17s reflect its partial availability for theater use. Its role must be considered.

- ACA AND ATT
- FUTURE THEATER AIRLIFT FLEET
  -- CH-47 + C-130 + C-17(-) + ACA(s) + ATT(s) = AIRLIFT 2010
  -- ACA(s) + ATT(s) + C-17(-) + C-130(?) + CH-47(?) = AIRLIFT 2020
- TRADOC'S ARCHITECTURE OF THE FUTURE
- TECHNOLOGICAL PROBABILITIES / POSSIBILITIES / COSTS
- COST - BENEFIT COMPARISONS AT DECISION POINTS

Figure 5-12. 21st Century Theater Airlift.

My second comment is to watch closely as TRADOC's Architecture of the Future unfolds. One of TRADOC's missions is to design the future Army. That process, illustrated in Figure 5-13, involves an evolutionary development based on "How To Fight" concepts, and focuses on 15-year developmental cycles. AirLand Battle defines how we fight now. AirLand Battle Future describes our concept of how we fight as the Army evolves over the next 15 years. Finally, Army 21 describes our concept of how we fight as we evolve from roughly the period 2003-2018. Obviously, what theater airlift needs to do must be based on how we fight. Therefore,

watch the progress of AirLand Battle Future and Army 21 closely. (Note: the numbers in parentheses of Figure 5-13 are currently approved milestones, but it looks like AirLand Battle Future will slip). Even though the Army is the biggest user of theater airlift, and thus the most likely design driver, other Service future concepts should also be watched.

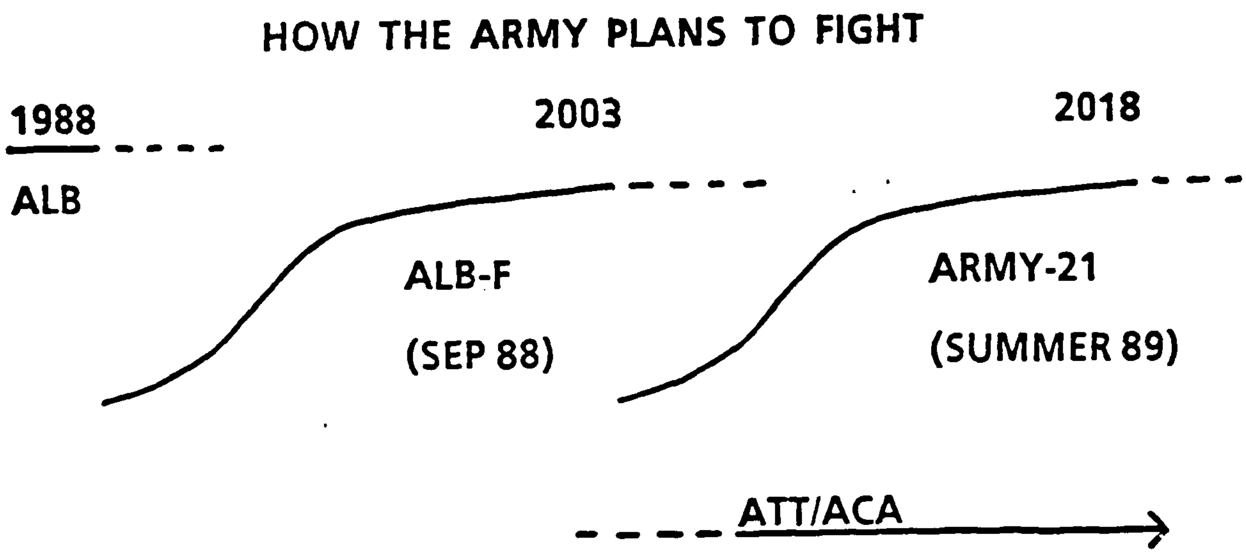



Figure 5-13. Architecture of the Future.

The importance of needs analysis needs to be stressed at this point. What do we need theater airlift to do? This mainly concerns the Army, is subjective in nature, and must be answered by the Army, but analysts can help by working through the question (your thinking is often better than ours), and posing questions to the decision makers.

Note the relationship of this question to the Architecture of the Future described above. The Army is not quite ready yet to firmly answer that question of what we need future theater airlift to do. We don't know yet how we plan to fight. But we all can start thinking about the answer and can formulate questions to clarify the answer. The Army must answer the question at some point in time.

My third comment is that interaction between the user requirements and technological possibilities is key to a proper solution. Requirements should drive technology, but they should be neither pie in the sky nor too conservative.

The term "Requirement" is a Pentagonese misnomer. For example, theater airlifter "requirements" are to carry a tank platoon, land vertically in a cow pasture, be invisible, be indestructible, and cost less than a Yugo. We tell you the type of things we would like to do, but technologists give us an idea of what is possible, and then we define the real requirement. Note that often technologists can suggest possibilities we never dreamed of. For example, the Army staff in 1895 was not thinking much about air power, but Orville and Wilbur Wright were.

My final general comment on theater airlift analysis is that we need cost-benefit comparisons at decision points. Bring the decision maker to the point of understanding that you can give him X capability for Y cost or Z capability for M cost. Do this where appropriate both for an individual aircraft design, and for various fleet mix options. (Note: the ATTMA studies generally did this quite well).

Turning to Service responsibilities (Figure 5-14), the definition of those responsibilities is a tough problem. The current status dates from 1966 when the Air Force was given responsibility for fixed wing aircraft and the Army was given responsibility for rotary wing aircraft. Is this situation right for the future? It is mainly a subjective decision, but analysts can help by showing how aircraft capabilities can define logical jobs for fixed versus rotary wing aircraft, and by a detailed analysis of required jobs. If the job is only for the Army, it normally should be done by Army aircraft. If the job is more general, satisfying theater level needs, it should be done by Air Force aircraft. In my office, we are suggesting an operationally, rather than a technologically, based criteria: If the mission is intra-corps, it should normally be handled by Army airlift; if it is a theater or into-corps mission, the Air Force should handle it.

| ARMY | BOTH | AIR FORCE |
|---|---|---|

Figure 5-14. Service Responsibilities.

The remainder of this presentation deals with Measures of Effectiveness (MOE) for theater airlift. A proper selection or development of MOE is very important to useful analysis. What factors tell me if one system or combination of systems is better for theater airlift? That is a tough question; much tougher than for strategic airlift because it involves many more variables. I will offer some opinions.

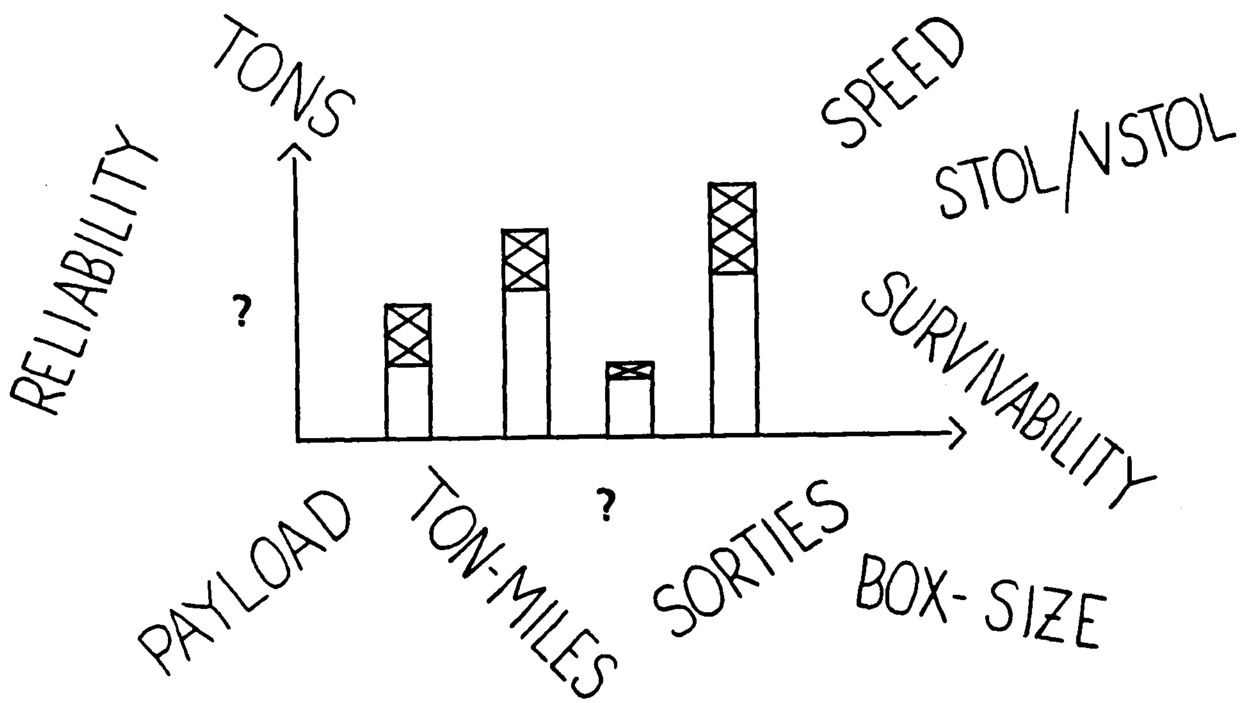



Figure 5-15. Measures of Effectiveness for Theater Airlift.

The ultimate MOE is battlefield outcome. As will be discussed in later presentations, Vector Research, Inc., has done a study for Lockheed and LTV has done several studies jointly with McDonnell Douglas using this MOE. This is certainly asking the right question.

This MOE may be good for convincing Congress and the Press. However, it is not very useful for senior military decision makers. Why? We must recognize that there are two analyses involved: what airlift moves, and; how a war is fought. The second analysis depends on a lot of things unrelated to airlift. I have to believe the wargame before I can believe what you tell me about airlift.

Let us consider an example. Airlift Option A moves a Motorized Division 300 miles from Point A to Point B in four days. Airlift Option B is able to accomplish the same move in two days. Now the impact of those two days on the battle outcome is very scenario dependent. Everyone knows that quicker is better. I'm going to tend to use my professional judgement (based on experience, and other war games) to decide whether Option B's delta is worth the cost.

In other words, the difference in time for a given move tells me a lot. However, the significance of that time differential on the battlefield outcome is another question. What, then, are the measures of effectiveness that are useful for senior military decision makers?

First, let me consider MOE related to specific capabilities of an airlifter as outlined in Figure 5-16. Note that to us the term "user" means the user of airlift service, not the user of the aircraft.

To the user, important MOE include speed, range, payload, and delivery field capabilities. The factors of speed and range are tied to what that means on maps, i.e., the ability to move something in time. Payload is related to what the aircraft can and can't carry. These are specific pieces of equipment or types of units; what units are excluded, or what within a unit is excluded from a move. For example, moving only 75% of an artillery battery may be all right if what's left behind is the mess truck and the Officer's Club van, but not all right if what's left

behind is six 155mm howitzers. Where it can go is a measure of what type airfields are required, i.e., is the airlifter CTOL, STOL, or VTOL? Also, it is important to measure where it can go in relation to the Threat.

| USER (AIRLIFTEE) | PROVIDER (AIRLIFTER) | |
|---|---|---|
| SPEED | GROSS WEIGHT | CREW |
| RANGE | SURVIVABILITY | SIZE |
| PAYLOAD | NAVIGABILITY | C3 |
| - WHAT IT WILL CARRY | PERFORMANCE CHARACTERISTICS | |
| - WHAT IT WON'T CARRY | SUPPORT REQUIREMENTS | |
| WHERE IT CAN GO | GROUND MANEUVERABILITY | |
| | NBC ENVIRONMENT CAPABILITY | |

Figure 5-16. MOE - Specific Capabilities.

To the provider, important MOE are related to aircraft performance and ability to accomplish the mission. These MOE include gross weight and fuel carrying capability, crew requirements (to include training), physical size of the aircraft, performance, survivability, support requirements (to include onload and off-load), ground maneuverability, navigability (to include self-navigability), NBC environment, and $C^3$.

Another set of MOE deal with the results of airlift (Figure 5-17). Ton-miles capability is useful as a broad, gross measure of Air Force airlift. It sets minimum capability, but simple ton-miles measurement leads inevitably to a fleet of C-5s as the best airlift solution.

Ultimately it is necessary to do scenario comparisons by theater. When possible for a given scenario, your analysis should generate individual sorties because often theater airlift requires half-empty aircraft. MOE include tons delivered (taking into account MOG, ground times, refueling, etc.), what is delivered (or more precisely, what is not delivered), closure (timliness of delivery), where it is delivered (how close to the final destination; link it with the ground move to determine how long it takes and how much effort it takes to get the load to its real final destination), and additional requirements (new MHE, special rigging, etc.).

**RESULTS OF AIRLIFT**

**TON - MILES ??**

**BY SCENARIO / (BY SORTIE)**

**TONS DELIVERED** | **WHAT DELIVERED**

**CLOSURE** | **WHERE DELIVERED**

**ADDITIONAL REQUIREMENTS**

Figure 5-17. MOE - Scenario Dependent.

Finally, the specter of survivability, or the other side of the coin, attrition, is very important to both the airlifter and the airliftee (Figure 5-18). This is an exception to my earlier comment suggesting that normally you don't need to tell decision makers how you did your analysis. You need to explain the specifics of your analysis system for the decision maker to believe you.

Survivability from ground-to-ground attack is a big concern. The issue is indirect fire. No airlifter will survive long if subject to direct fire on the ground. The factors of ground-to-ground survivability are where the airlifter is on the ground in relation to enemy artillery, how long it remains on the ground, the enemy's targeting capability, the probability of hit (PH) and probability of kill (PK) of systems, and the enemy targeting decision.

Those factors are probably listed in order of their significance. The targeting decision is hard to predict, but a big airlifter on the ground is a sitting duck and is probably worth a few rounds. The PH of rounds can be obtained from artillery sources such as Fort Sill and PK is probably similar to those for ADA models, but it is a fairly good assumption that if targeted by much more than a guerilla mortar, a large stationary aircraft won't survive much observed or registered indirect

- GROUND - TO - GROUND

1. WHERE
2. HOW LONG
3. TARGETING CAPABILITY
4. PH / PK OF SYSTEM
5. TARGETING DECISION

- GROUND - TO - AIR
- AIR - TO - AIR
  -- FIXED WING
  -- HELO'S

Figure 5-18. MOE - Survivability/Attrition.

fire. The enemy targeting capability may differ a lot by scenario and is definitely a factor of predictability of the target; fewer airfields that are possible for the airlifter to use equals easier targeting. Finally, the two key factors are where and how long the airlifter will be on the ground (a moving target is hard to hit).

Survivability from ground-to-air attack is the toughest. You need to convince me your data is believable. I find widely differing results from airlift attrition studies. The challenge is to look for an agreed upon mean.

With respect to air-to-air survivability, if you can do much better than 25%, you must be convincing. In general, assume the air-to-air attacker will win if he wants to. And don't forget helicopters as air-to-air killers.

Include your best guess on threat technology development. Don't tell us that you can make an aircraft survivable against an SA-7 if the SA-7 is going to be an SA-19B. For example, is sound detection going to replace radar detection?

A further step in MOEs is to put attrition and other measures together for productivity over time of a given system and of a fleet.

The final MOE is cost. I don't have to say much on how to most honestly and realistically determine costs. Life cycle costs are more real than single item costs, but they may be less sellable because they are more subject to manipulation. You must convince the decision maker and help him to convince others. Don't forget things like manpower, operations and maintenance (O&M), and other support equipment required (e.g., if you buy a new dress, you need new shoes also).

To briefly review the high points of this long and action packed presentation:

I commented first on philosophy related to analysis. Learn to help the user to define what he wants you to do. Gear your efforts towards bringing him to clearly defined decision points, and focus your presentations on these decision points. And, Keep It Simple Stupid! Remember, he probably doesn't know or care much about the technical aspects of your analysis. He wants to know what your assumptions were, what your results were, and how believable you think those results are.

In comparing theater airlift with ground transportation, airlift has the primary advantages, in order, of flexibility, responsiveness, and speed.

Remember the five main mission categories of theater airlift: deployment, employment, sustainment, retrograde, and aeromedical evacuation. Since each requires different things from airlift, you may need to separate them so you can separate which are the real design drivers.

Finally, I talked about analysis of theater airlift. Since I just finished the discussion, I won't review what I said, except that I suggested some ripe fields for analysis and some thoughts on measures of effectiveness.

In closing, I would like to say that I have really appreciated the opportunity to participate in this meeting. When I came into my job at ACRA about three years ago, I was both a dummy and a skeptic as regards the type of things you guys do for a living. When you are an ignorant peasant dealing with wizards you tend to either idolize them or think they are mainly smoke blowers. I am now an only-slightly-less ignorant peasant, but I have rubbed shoulders with the wizards enough to have a lot of genuine respect for them. Some are smoke blowers, but a lot - like Mike McManus, Lud Vukmir, and Dr. Seth Bonder, don't blow smoke, and as one on the fringes of high level decision making, I am anxious to get all the help I can from the analysis community.

COL Shine has an MA degree in history from Harvard and has taught that subject at his alma mater, West Point. However, he has had a unique and very important mission for the past three years as Deputy Director, and now Director, of the Airlift Concepts and Requirements Agency (ACRA), a bi-service operating agency of the Military Airlift Command (MAC) and the Army's Training and Doctrine Command (TRADOC). COL Shine is an infantry officer with 24 years commissioned service with duty in regular and air assault infantry units. He served in Vietnam as an advisor to a Vietnamese Ranger Battalion and as a rifle company commander with the First Air Cavalry Division. He commanded an infantry basic training battalion prior to assuming his present duties. His decorations and awards include the CIB, Silver Star, Bronze Star, and Meritorious Service Medal.

# CHAPTER 6

# CHALLENGES IN TRANSPORTATION MODELING

by COL William A. Smiley, USAF

ABSTRACT: This presentation provides insights, from an OJCS perspective, of progress and problems in Strategic Mobility assessment. New JCS responsibilities under the DOD Reorganization Act of 1986 provide the backdrop for initiatives now underway to develop integrated modeling structures designed to improve advice to National Command Authorities.

Current capabilities are summarized and deficiencies highlighted. Recent trends in assessing the impact of strategic mobility resources are described. These include improvements to existing analytical models and development of dynamic interfaces to scenario based wargaming models. Finally, some ideas for solving current dilemmas are presented.

## 6.0 PRESENTATION OUTLINE.

I - Background

II - Strategic Mobility Modeling

III - Trends in Capability Assessment

## 6.1 BACKGROUND.

The Goldwater-Nichols Department of Defense Reorganization Act of 1986 contained major changes in the role of the Chairman of the Joint Chiefs of Staff. He was given responsibility for the strategic direction of the Armed Forces to include resource constrained strategic planning. To meet those responsibilities, the law directs establishment of a military net assessment process to compare the capabilities of the U. S. and Allied Armed Forces with those of potential adversaries. The net assessment is used to develop recommended alternative strategies to guide the Chairman in providing direction to the Armed Forces.

The military net assessment is conducted on a biennial basis with the Directorate for Force Structure and Assessment (OJCS/J-8) as the lead agency. The objectives of the assessment are to measure risk and develop options to lower those risks. The process includes the use of force-on-force wargaming, static assessments, and seminars. We completed the first Military Net Assessment last summer (1987).

The logistics aspects of the military net assessment, outlined in Figure 6-1, focused on analyses of strategic mobility and of sustainability. The results were extremely limited because of inadequate tools--a problem we are working on fixing for future cycles.

* *STRATEGIC MOBILITY ANALYSES*
  - *CONSTRAINED RESOURCES*
  - *FORCE CLOSURES*
* *SUSTAINABILITY - <u>STATIC</u> ASSESSMENT*
  - *INDUSTRIAL BASE*
  - *WAR CONSUMABLES*
  - *READINESS*

Figure 6-1. Military Net Assessment - Logistics.

To understand our difficulties, you should note that joint staff perspectives have traditionally been different from Service staffs. On the joint staff, we have focused on "near term" operational assessments that do not have clear parallels in the Budget and Program assessment world of OSD and the Services. Some of the similarities and differences are shown in Figure 6-2.

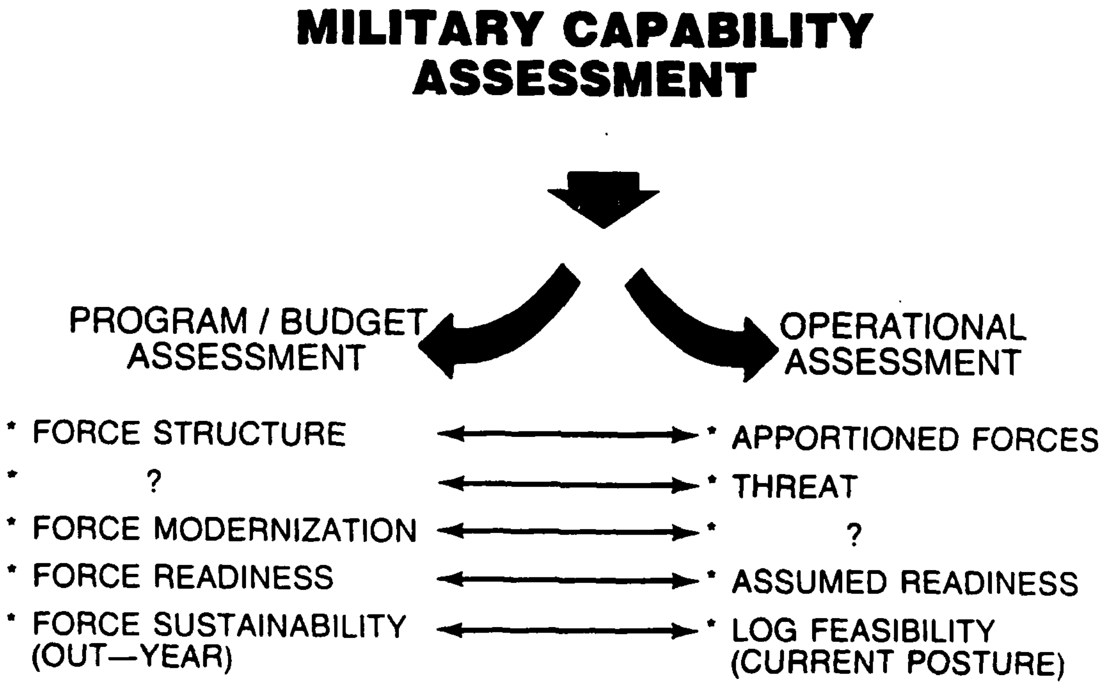



Figure 6-2. Military Capability Assessment.

These different perspectives typically lead us to different approaches as described in Figure 6-3. Analytical models are usually used to prepare program or budget assessments. A limited number of resources which have easily understood relationships are compared. The typical output is the cost for some static measure of merit. Simulation models are used for operational assessments involving multiple resources with complex relationships. The typical output of these models are force-on-force results over time. Analytical models are designed to develop solutions which meet the defense guidance goals, but simulation models may demonstrate that those solutions are inadequate or out of balance.

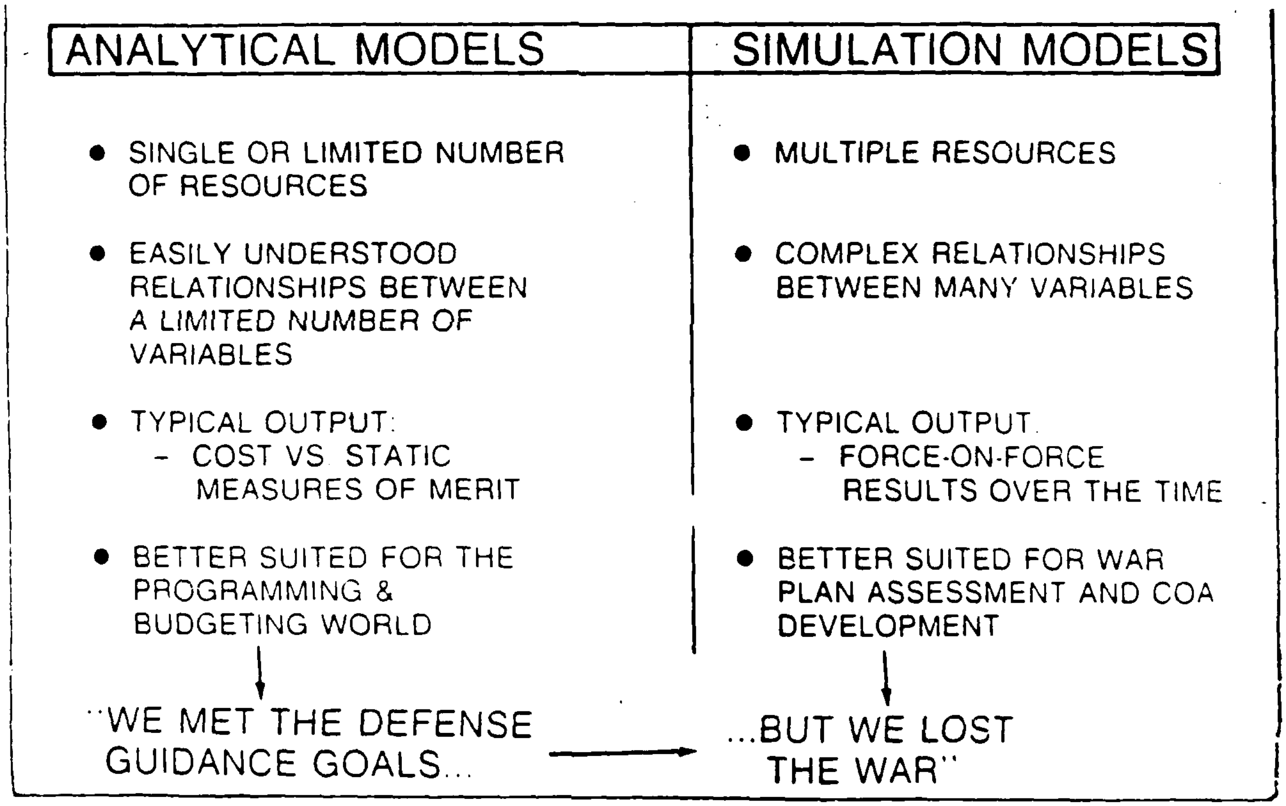



Figure 6-3. Capability Assessment Models.

A multitude of complex relationships go well beyond our capability to accurately simulate. As shown in Figure 6-4, the military capability of the combat unit at the front line depends upon an extensive support structure including its own organic support base, the tactical lines of communication (LOC), the theater support base, the strategic LOC, and the CONUS support base--truly a global perspective support structure. A full understanding of the unit's capability requires analysis of all of the components shown in the figure as well as their interactions.

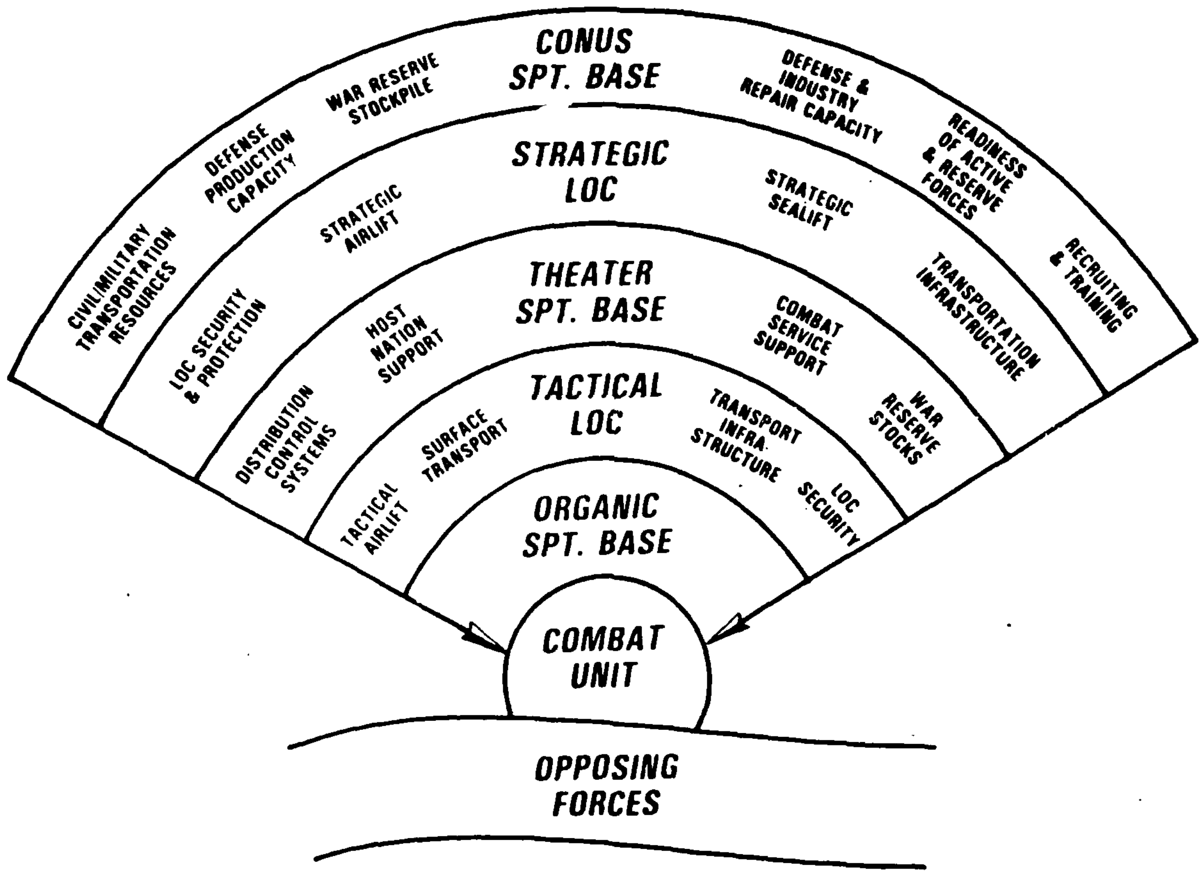



Figure 6-4. Military Capability of the Combat Unit.

Today we model some pieces of the puzzle and have a pretty good understanding of some interactions. In the following charts, I'll describe how we have improved our use of strategic mobility modeling and how we have applied it to the military net assessment problem.

## 6.2 STRATEGIC MOBILITY MODELING.

An essential element of military capability is "Force Projection," or the ability to move combat and support forces where they are needed in a rapid fashion. Strategic mobility is the term we use to describe the resources needed to support this mission. This section describes the dimensions of the strategic mobility modeling problem, discusses the model we use to include its data requirements and some applications, and concludes with a discussion of mobility modeling limitations and problem areas.

Figure 6-5 illustrates the dimensions of the strategic mobility analysis problem. The three primary dimensions of airlift, sealift, and prepositioning are the traditional variables. More recently we have developed the ability to fully explore the impact on the mobility resource equation, of unit availability--i.e., how does the "readiness" of reserve units affect the need for airlift, sealift, or prepositioned material.

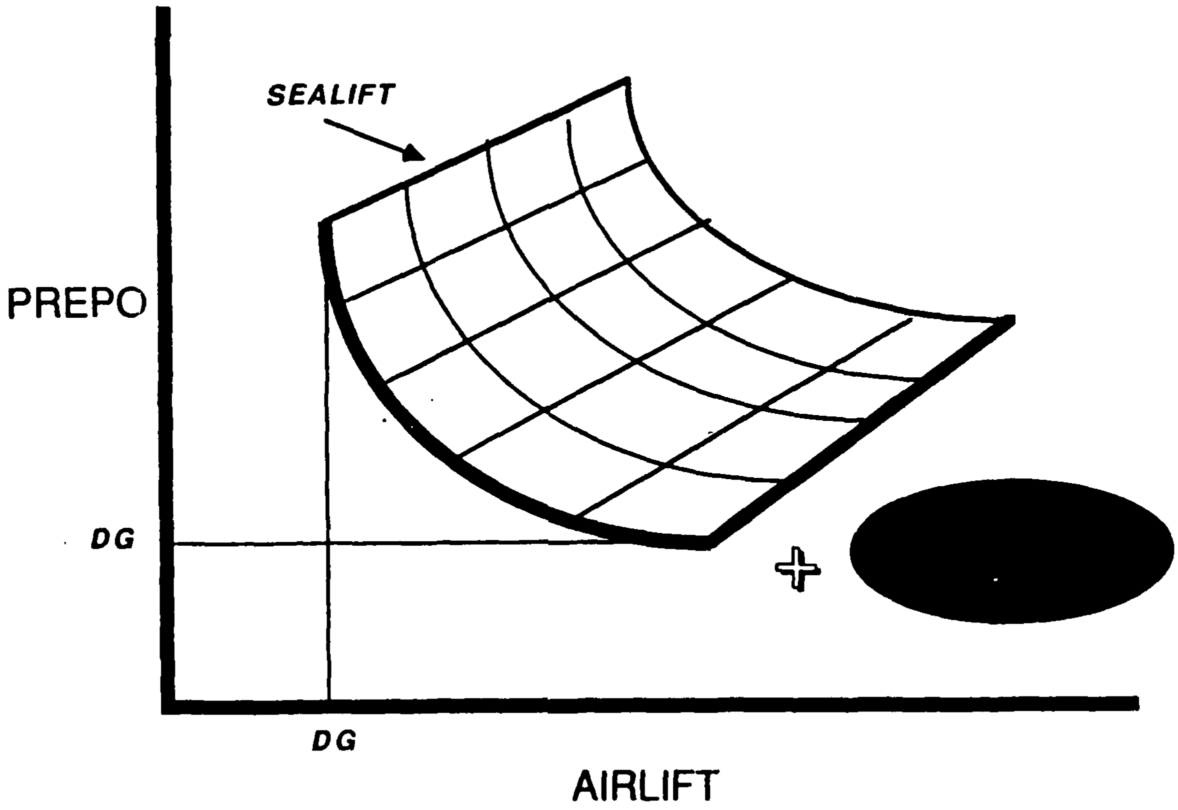



Figure 6-5. Strategic Mobility Trade-Off.

The tool widely used for this mobility analysis in OJCS and OSD is the Model for Intertheater Deployment by Air and Sea (MIDAS). Its primary inputs and outputs are shown in Figure 6-6.

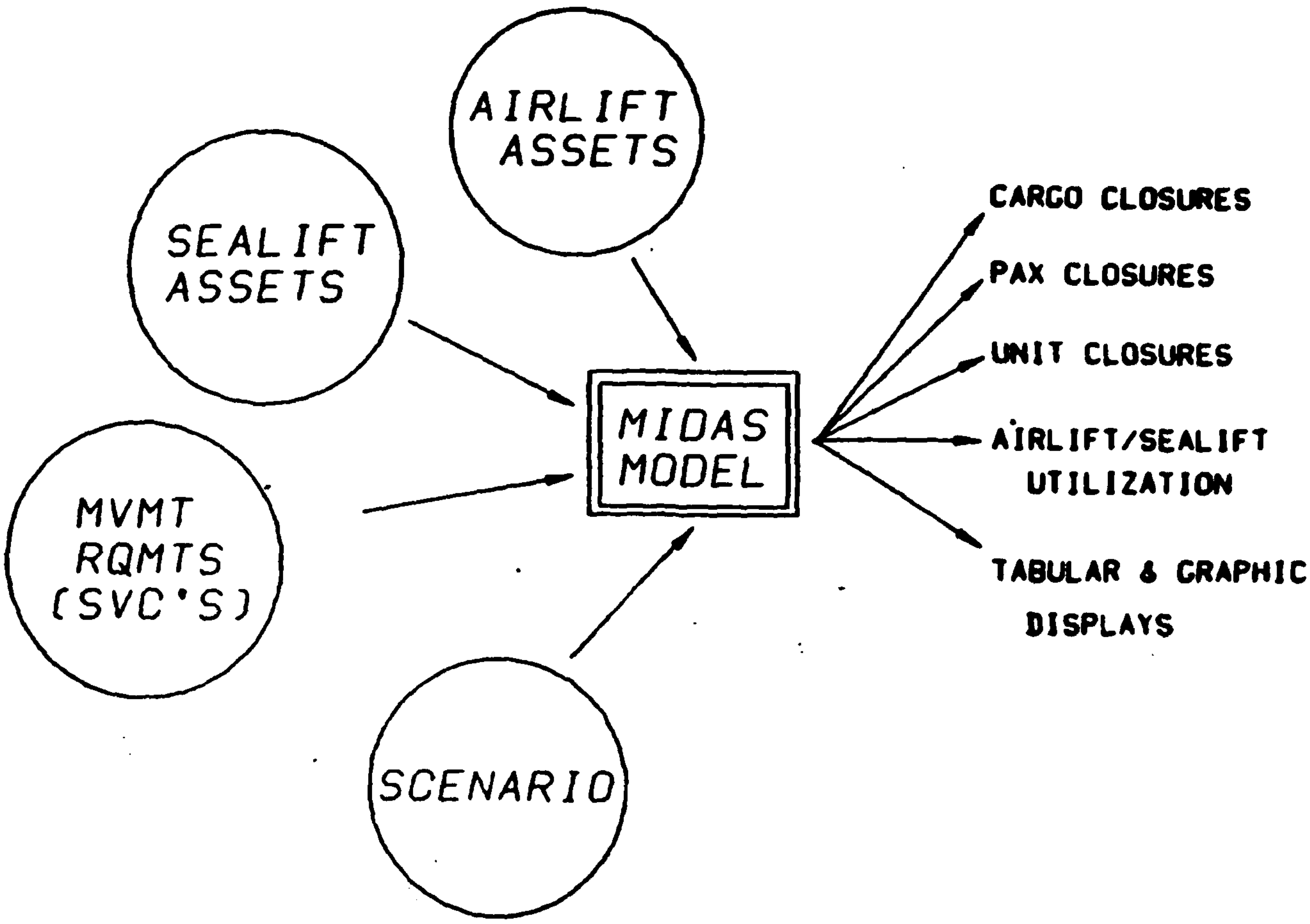



Figure 6-6. MIDAS Model.

Up to 10 aircraft types can be defined in MIDAS to include their air cabin loads by cargo type and airframe, UTE rates which are variable over time, and their bulk, oversize and outsize cargo capacity. U.S. and Allied aircraft are used for cargo and passenger movement. Passengers are scheduled to arrive coincident with their cargo. Multiple theater operations can be modelled and MIDAS airlift is allocatable by percent to each theater over time.

Sealift assets consist of actual ship files provided by Military Sealift Command. Each ship in MIDAS is loaded and tracked individually. Ship loading characteristics include the type of ship (breakbulk, RO/RO, container, etc.) and its storage capacity in metric tons or square feet. Sealift is organized by fleets: Military Sealift Command (MSC), U.S. flag, Ready Reserve Force (RRF), National Defense Reserve Fleet (NDRF), Effective U.S. Control (EUSC), and NATO shipping pool. Finally, ships are scheduled for loading based on port availability and capacity and on which ships are available.

The movement requirements data bases for MIDAS are outlined in Figure 6-7.

* EXTREMELY DETAILED DESCRIPTION OF CARGO

  - CONUS AVAILABILITY, RDD

  - PHYSICAL CHARACTERISTICS DESCRIPTION
    - -- WEIGHT, MEASUREMENT TONS, OVERSIZE, OUTSIZE, BULK
    - -- TRACK, WHEELED, AVIATION
    - -- CONTAINERIZABLE

  - DESTINATION

* PREPARED BY SERVICES

  - DATA BASES VERY LARGE (APPROX 40,000 LINE ITEMS TO MOVE)

  - TPFDD LEVEL OF DETAIL

* PREPARED TO REFLECT SCENARIO (DG GLOBAL WAR, NATO RRP, ETC)

Figure 6-7. Movement Requirements Data Bases.

Various scenario controls are employed. The conflict is defined for the theater with time lines. CONUS movement POEs are designated. The strategic lift is allocated and attrition of lift can be considered. Additional intratheater factors such as reception and onward movement are considered and included.

The two application modes for this analysis are shown in Figure 6-8. In the capability assessment mode, strategic mobility assets are evaluated for their ability to meet movement requirements in providing a desired closure capability. In the requirements mode, the analysis is used to determine strategic mobility options which satisfy the closure requirements. The MIDAS model does the first task (assessment) well, as that is what it was designed to do. As a "requirements" model, it has significant limitations, since a multitude of combinations of airlift, sealift, and pre-positioning may solve the requirement equation, or, if unit readiness is insufficient, no amount of strategic lift resources will close the force on time. Using MIDAS in the requirements mode is an "art" not a science.

★ *CAPABILITY ASSESSMENT MODE*

$$\begin{array}{c}\text{MVMT}\\ \text{RQMT}\end{array} + \begin{array}{c}\text{UNIT}\\ \text{READINESS}\end{array} + \begin{bmatrix}\text{AIRLIFT}\\ \text{SEALIFT}\\ \text{PREPO}\end{bmatrix} \longrightarrow \begin{array}{c}\text{CLOSURE}\\ \text{CAPABILITY}\end{array}$$

★ *REQUIREMENTS MODE*

$$\begin{array}{c}\text{MVMT}\\ \text{RQMT}\end{array} + \begin{array}{c}\text{UNIT}\\ \text{READINESS}\end{array} + \begin{array}{c}\text{CLOSURE}\\ \text{RQMT}\end{array} \longrightarrow \begin{bmatrix}\text{AIRLIFT}\\ \text{SEALIFT}\\ \text{PREPO}\end{bmatrix}$$

Figure 6-8. Applications.

How does MIDAS work? The total deployment requirement can be viewed as the pie shown in Figure 6-9. Some cargo is prepositioned (MIDAS ignores). Some cargo is directed by the Services to go by air or by sea (MIDAS applies resources accordingly). Finally, a significant portion is allowed to go by any mode and here MIDAS must make decisions. Those decisions are determined by the time period (or "window") provided, that is, the period defined by the cargo availability date and the required delivery date. This is illustrated in more detail on the next figure.

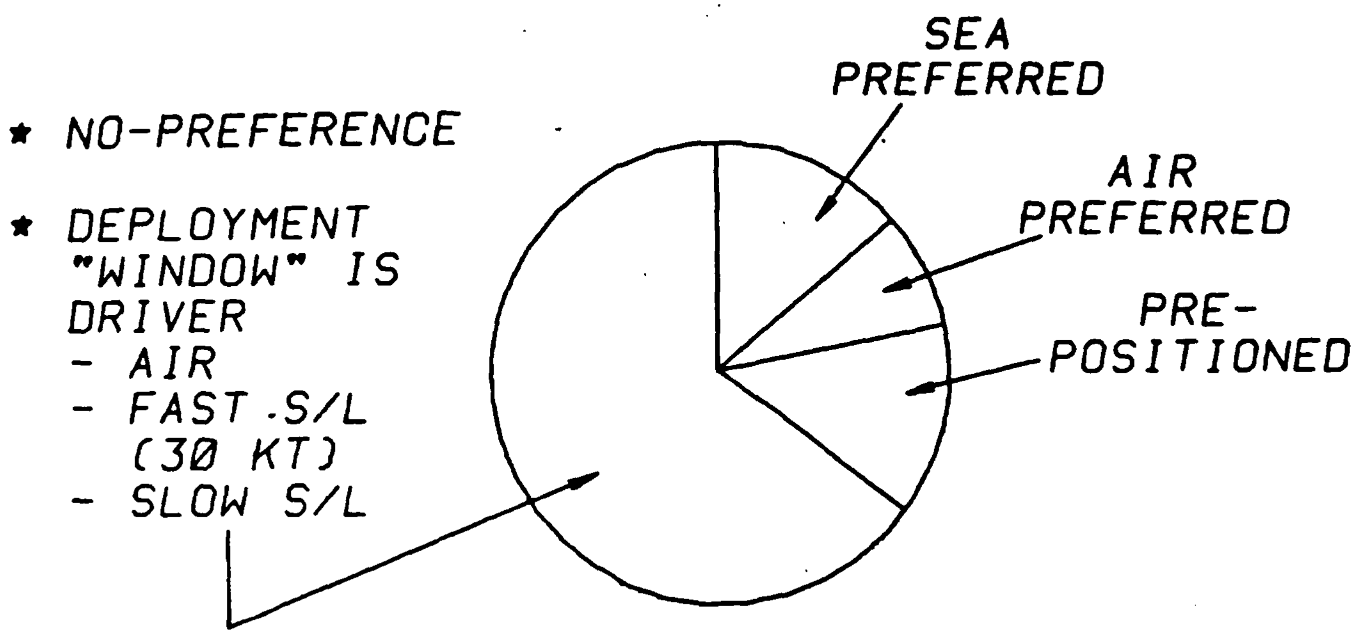



Figure 6-9. Total Deployment Requirement.

Using the methodology of the Revised Intertheater Mobility Study (RIMS) as an example (Figure 6-10), the deployment window is calculated as shown. The RDD is the required delivery date while the availability date is the earliest time that a specific movement can start.

That window is compared to the closure date possible from the movement options shown to determine the movement mode. In essence, we move the requirement from right (slow sealift) to left (airlift or prepo) until we find the mode which closes the cargo on or before it's RDD. Most importantly, however, we can determine by how much we need to open the deployment window, adjusting the availability date, in order to move a requirement from the airlift mode to a sealift mode.

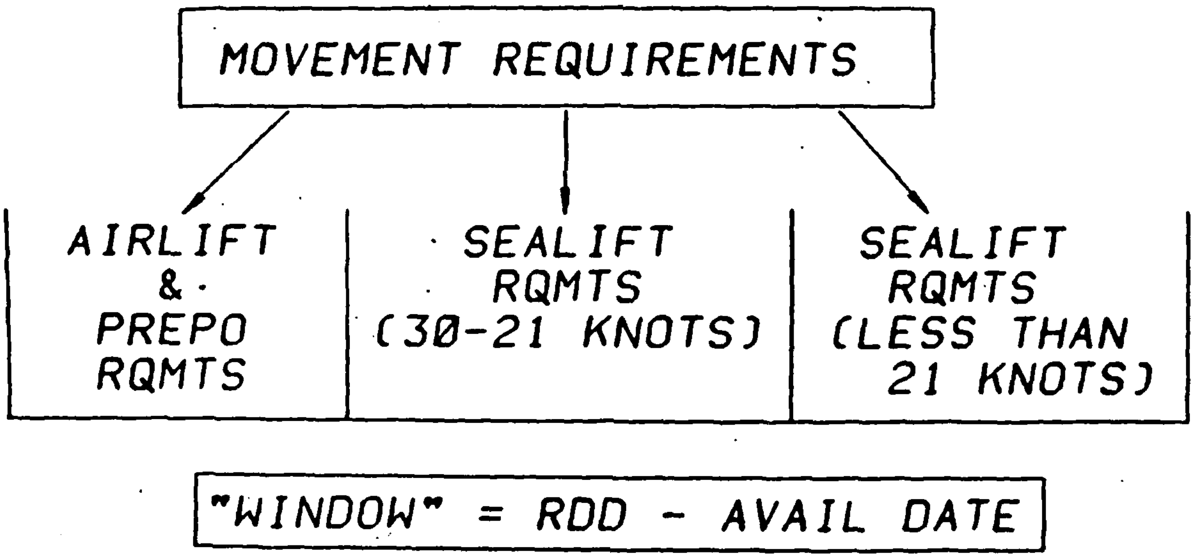



Figure 6-10. Deployment Windows.

So far the results from this methodology developed for the RIMS have been promising. We can now perform trade-off analyses between unit availability and alternative lift resource mixes. A significant question remaining is how to determine the cost of improving unit readiness vice buying more strategic lift assets.

In spite of improvements made to a very good model, major deficiencies remain in the data base complexity and the ability to use the methodology in the requirements mode. The data base problems result from errors which are time consuming to fix, complexity in establishing the linkages between combat and support elements, and the large size of the data base. Additionally there is only a very limited capability to evaluate strategic alternatives, and there is no significant interactive (start/stop) capability.

## 6.3 TRENDS IN CAPABILITY ASSESSMENT.

The traditional approach to Strategic Mobility assessment is illustrated in Figure 6-11. Scenario files and movement requirements are input to a mobility model such as MIDAS together with quantities and characteristics of airlift and sealift mobility assets. Prepo stocks are typically specified in advance. The model then calculates force closure information for the assessment.

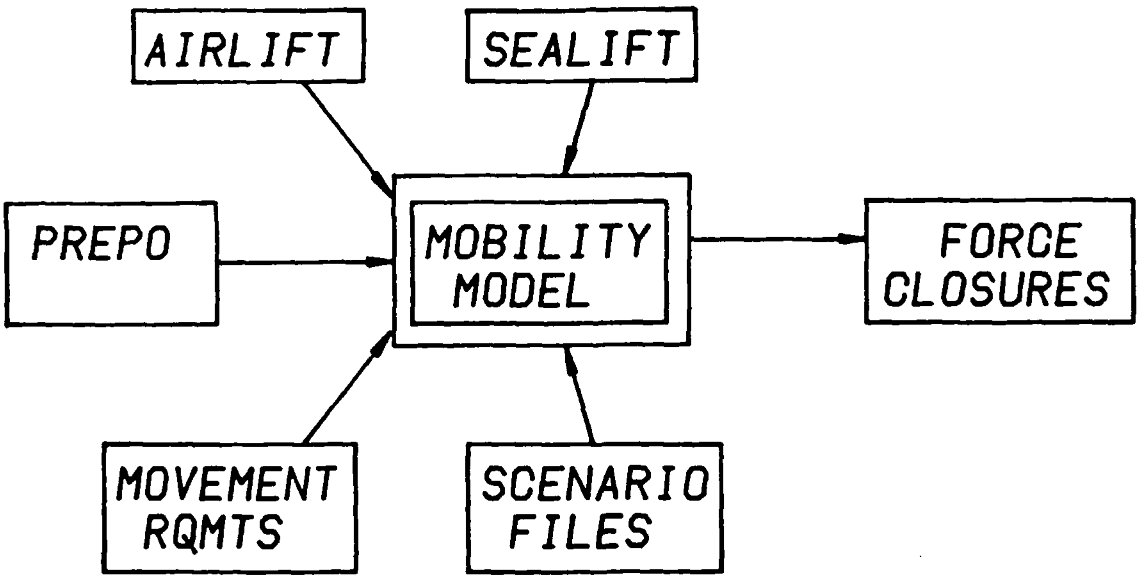



Figure 6-11. Strategic Mobility Assessment.

In recent years we have had a growing requirement to link results to other models as shown in Figure 6-12. A combat simulation, such as INBATIM or TACWAR which are used by the Joint Staff for force and strategy assessment, is linked to the mobility model outputs. Force closure information is input to the combat simulation to produce results showing the impact of strategic mobility on the combat outcome. While this improves the validity of the combat assessments, the static nature of the link-up has significant limitations.

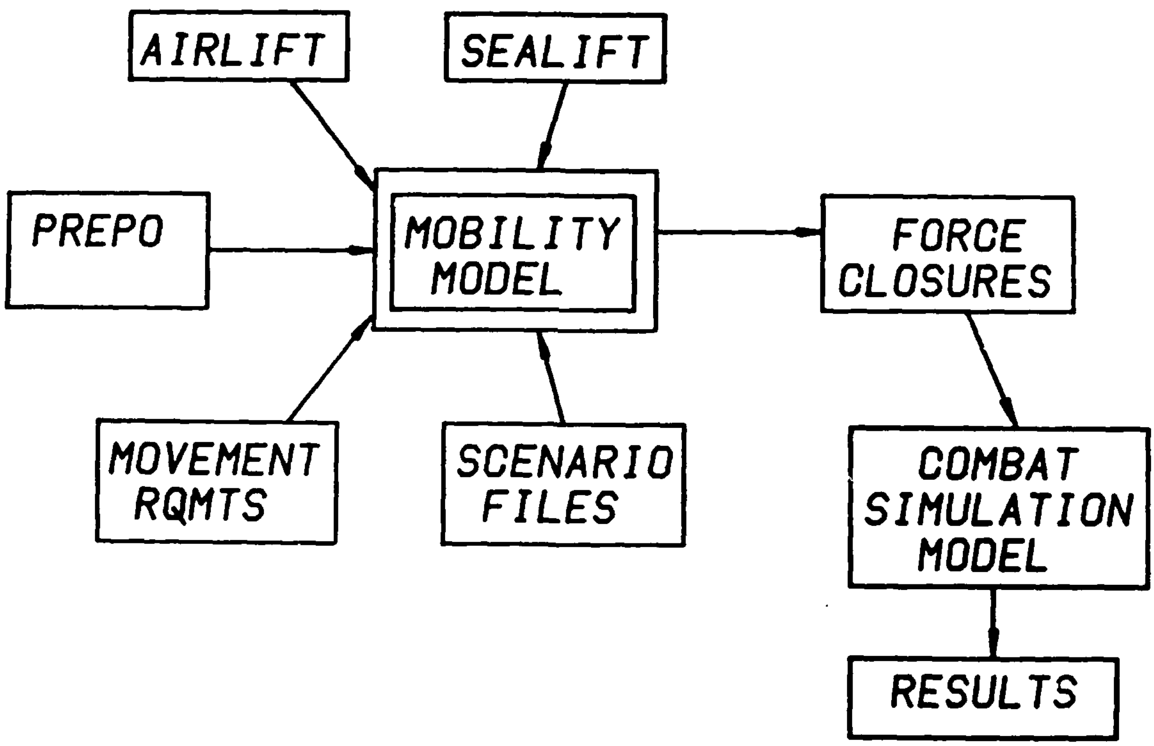



Figure 6-12. Strategic Mobility Assessment - Static Interface.

The next improvement we are striving for is illustrated in Figure 6-13. It reflects a dynamic interface between the mobility model and the combat simulation. Outputs of the combat simulation cause changes in the scenario file which, in turn, change the force closure data which again impacts the combat simulation results. Unfortunately, certain characteristics of the MIDAS model prevent us from full interactive play and these will take time to fix.

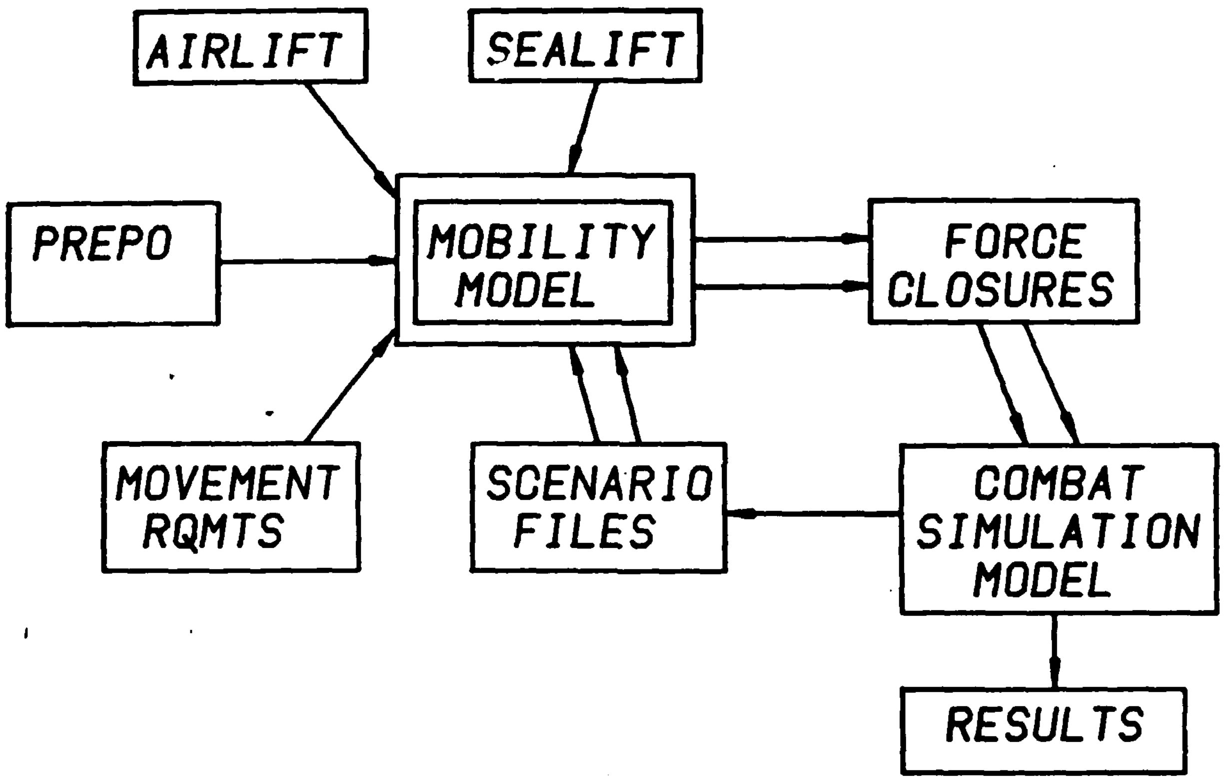



Figure 6-13. Strategic Mobility Assessment - Dynamic Interface.

Finally, a fully integrated approach to the same assessment is shown in Figure 6-14. This additional feedback could be used to develop alternative strategies through easily modifiable movement requirements and scenario files, that would give us a rapid response capability to develop and evaluate alternatives quickly - days instead of months.

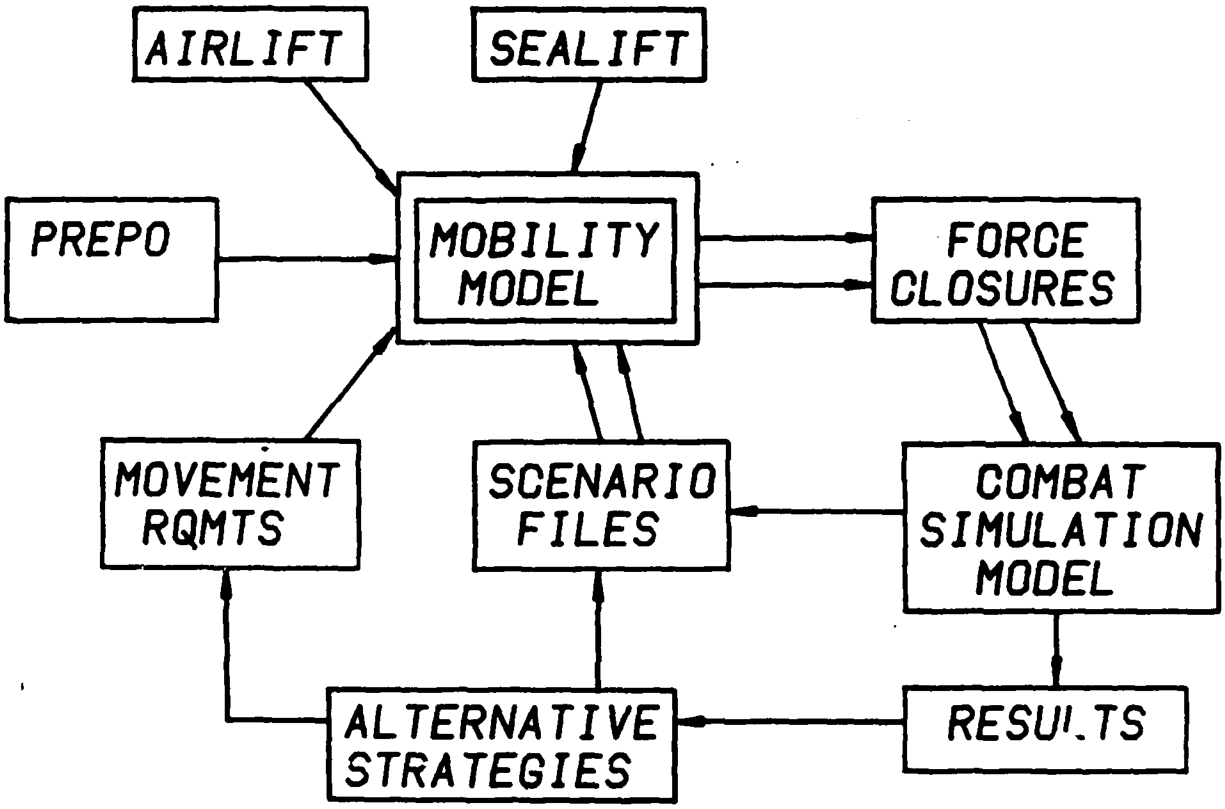



Figure 6-14. Strategic Mobility Assessment - Integrated Net Assessment.

While I have discussed one development track which represents an effort to move toward an integrated global assessment capability--other areas are also important: tactical mobility, war reserve inventories, and industrial mobilization, to name a few. None of these elements of military capability are modeled very well in either global or theater employment models.

They are modeled or assessed independently, usually with analytical models which use relatively static criteria, and it is a forgone conclusion that there will be a continuing need by the budget and programming communities for this approach to measure capability trends against fixed baselines.

As a design criteria, however, we would like to see such analytical models work interactively and in tandem with our growing arsenal of wargaming and simulation models. This would allow us to develop more balanced program goals, demonstrate the value of alternative resource programs on theater employment plans, and investigate the relationship between resource programs and alternative strategies.

While this architectural objective is challenging, we can accomplish some of these improvements through new programs such as the Joint Analytic Warfare System (JAWS).

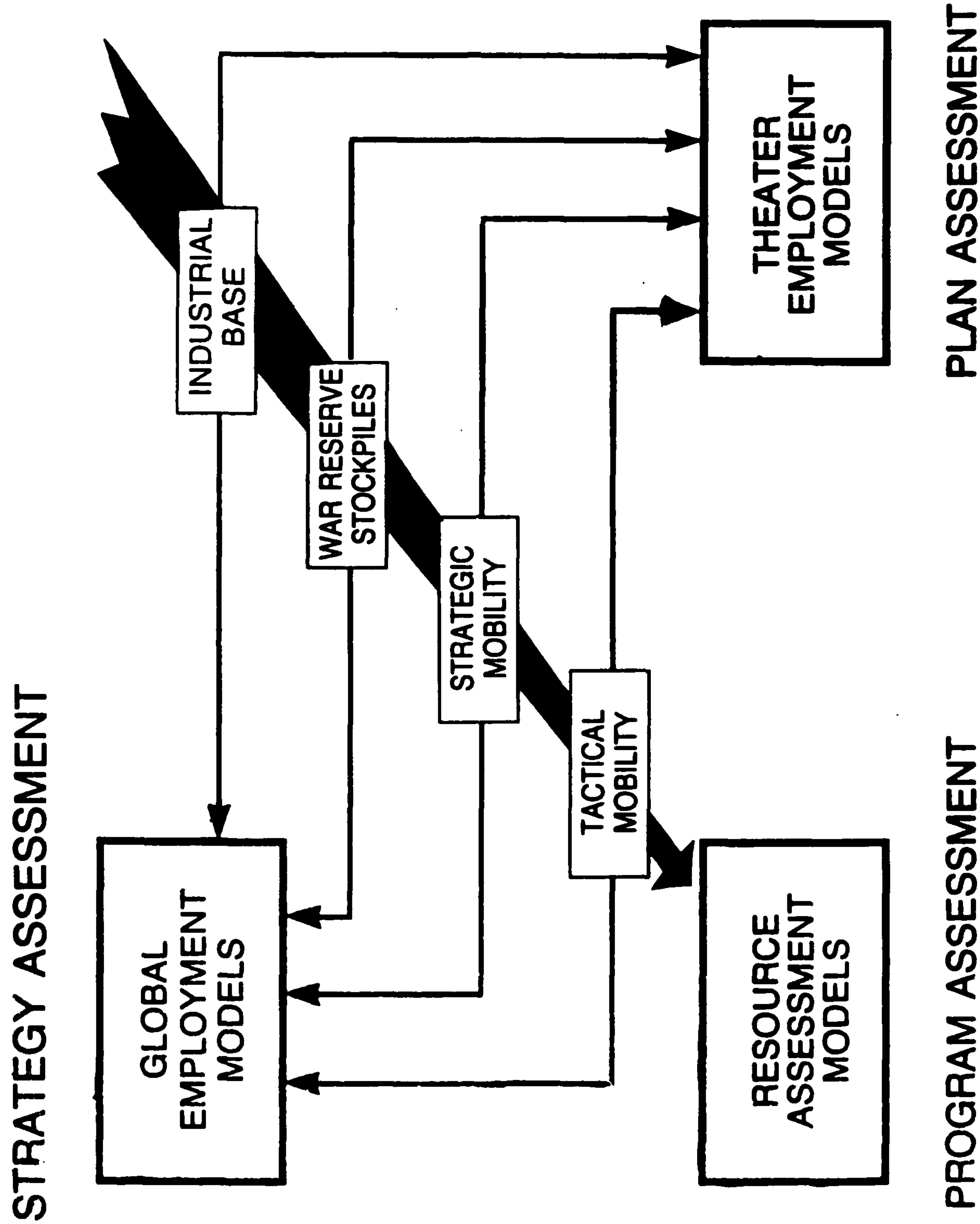



Figure 6-15. A Future Architecture?

What more appropriate way could there be to conclude this presentation than with a quote from Tom Clancy's Red Storm Rising. At a critical point in the war, Soviet General Alekseyev says (or would have said in his native Russian),

"Тактика ... нет, любители обсуждают тактику. Професcионалбные солдати учятся тюл и снабжение."

which Mr. Clancy records as, "The tactics...no, amateurs discuss tactics. Professional soldiers study logistics."

COL Bill Smiley has been Chief of the Studies, Concepts, and Analysis Division, Logistics Directorate, Organization of the Joint Chiefs of Staff for the past 2 1/2 years. A graduate of the College of Idaho, with an MS in Logistics Management from the Air Force Institute of Technology, he is also a graduate of the Air Command and Staff College and the Industrial College of the Armed Forces. He has served in a variety of logistics positions in his 25 years of service to include tours in Vietnam and with Headquarters, Allied Forces Central Europe. His decorations include the Legion of Merit, Bronze Star, and both the Defense and Air Force Meritorious Service Medals.

# CHAPTER 7

# REINFORCEMENT OF EUROPE

by Dr. Charlie Leake

ABSTRACT: There have been some recent efforts to study the alternative ways to reinforce or resupply the forces in Europe. One alternative was to consider reinforcing as a deterrent to war. This study showed that, with appropriate assumptions, timely arrival was possible without any additional resources required beyond what were already available. The results and methodology of this analysis are discussed.

However, the problem of congestion and onward movement from the APODS and SPODS was not considered in the earlier analysis. This is a more difficult problem and requires an integration of both intertheater and intratheater movements. These movements are presently complicated by host nation requirements. For example, if an APOD is in country A and the unit assembly area (UAA) is in country B, then country A provides host nation support to its border and country B provides the support from the border to the UAA. Moreover, these agreements must be negotiated in advance and are not handled by brief telephone conversations. Not all problems, however, are host nation. Some of the problems addressed in the ROME study by IDA are discussed in conjunction with the host nation problems. Suggestions for reducing the entropy in the system are discussed.

## 7.0 PRESENTATION OUTLINE.

I - USAREUR 10 in 10 Study

II - IDA ROME Study

## 7.1 USAREUR 10 IN 10 STUDY.

The purpose of this presentation is to provide some of the insights I've developed into the reinforcement of Europe problem that I've developed after having worked on it in Europe for over a year.

An old Chinese proverb states that a picture is worth a thousand words. The problem is massive, but I've attempted to condense it into Figure 7-1. Notice we have a series of buckets and pipes each emptying into each other and then finally into a reservoir. The pipe pouring into

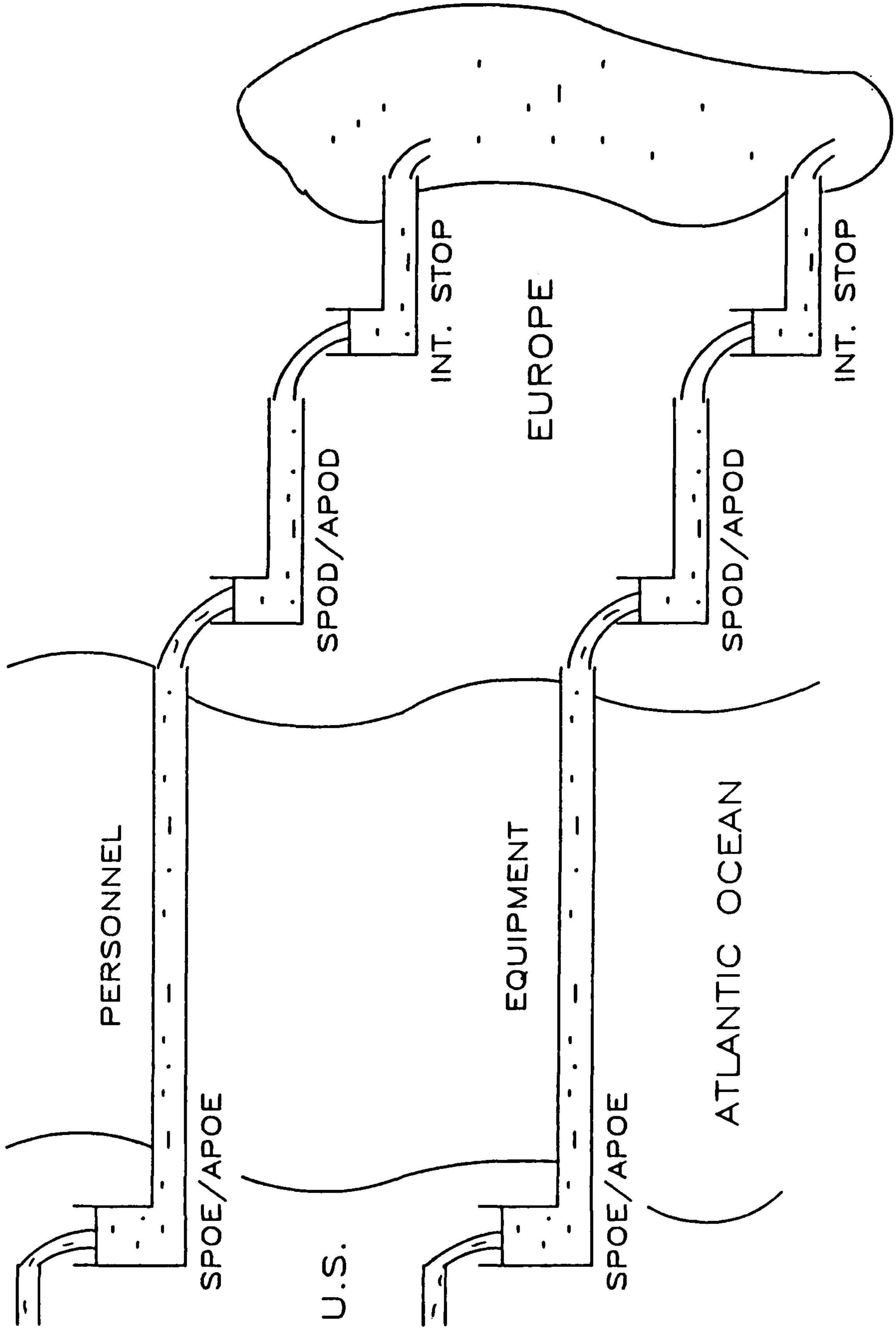



Figure 7-1. Statement of the Problem (Simplified).

the first bucket represents the troops and equipment entering into their SPOEs and APOEs. The pipelines are our strategic lift. They flow into another set of buckets which are the SPODs and APODs in Europe. They flow out of these buckets using the intratheater transportation network such as the railroad, road, and inland waterway network. Sometimes there is an intermediate stop to pick up POMCUS for example. Naturally, although not shown on the picture, the personnel need to marry up with the equipment. This is done rather well, I might add and was omitted as an artist's prerogative All of this flows into the unit assembly areas which are indicated by the reservoir.

The present methodology is to use the TPFDD, STANAG 2165, and national movement plans. As outlined in Figure 7-2, the Time Phased Force Deployment Data (TPFDD) is a U.S. only document not available even to NATO members. It is a very detailed document that is difficult to read, change, or develop. Its software is in COBOL and it runs on a 1969 vintage computer. If you can figure out how to read a magnetic tape of the document, it is an excellent source of data. It is supposed to be used for planning purposes.

- US PLAN NOT AVAILABLE TO NATO NATIONS
- VERY DETAILED
  - DIFFICULT TO READ
  - DIFFICULT TO CHANGE OR DEVELOP
  - SOFTWARE/HARDWARE FOR ANALYZING IT IS 1969 VINTAGE
- EXCELLENT SOURCE OF DATA
- PLANNING DOCUMENT

Figure 7-2. TPFDD.

The STANAG 2165 is a sanitized version of the TPFDD for each NATO nation that gives a summary of U.S. movements within their borders. It is presently available in hard copy format. We at the SHAPE Technical Centre have received a magnetic tape of the hard copy (a total of 10 9-track magnetic tapes). The documents are not easy to read and plan from. However, it too is an excellent source of data.

Based on the STANAG 2165 and other national movement plans, each nation draws up a movement plan within their borders. These are presently being formulated. All these plans leave something to be desired. For example, the U.S. plan has its forces arriving later than desired. One of these is the 10 in 10 U.S. force, i.e., ten divisions in ten days.

- NATIONAL VERSION OF TPFDD
- HARD COPY
- TRUNCATES AT DAY 30
- DIFFICULT TO READ AND ANALYZE
- EXCELLENT SOURCE OF DATA

Figure 7-3. STANAG 2165.

CINC USAREUR requested the ORSA Cell to find a way of bringing the necessary equipment to Europe in order to have 10 divisions in Europe in 10 days. I'll cover this study, called the USAREUR 10 in 10 study a little bit later. IDA also conducted a study, called the ROME study, which had to do with the reception and onward movement in Europe of the total reinforcing force. This study will also be addressed shortly.

Figure 7-4 gives an overview of the 10 in 10 study. It is concerned with getting equipment from U.S. ports to Europe. In other words, just a small piece of the puzzle, and only for the 10 in 10 force.

The study provided some interesting results. The most significant conclusion was that no more assets were required to meet the 10 in 10 lift requirements. The study also included the development of a model which allowed the evaluation of a number of assumptions such as ports, ships, and aircraft availability, unit availability, and timeliness of important decisions. Overall the study was concerned with the deterrence effect of moving 10 divisions in the 10 days.

The study demonstrated that given timely intelligence and decisions as well as the current level of POMCUS and host nation support (particularly sea lift), moving 10 divisions in 10 days is a distinct possibility.

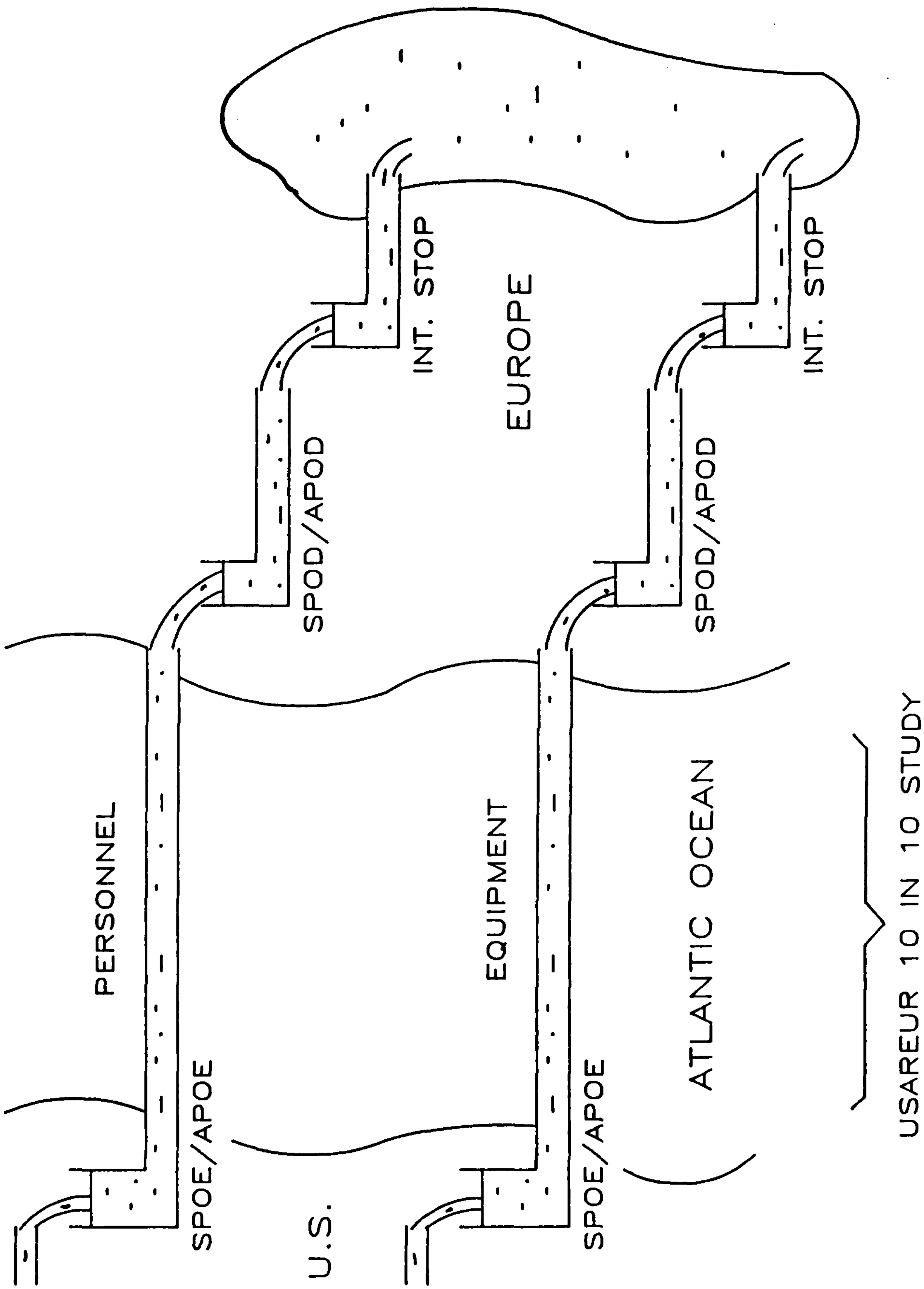



**Figure 7-4. USAREUR 10 in 10 Graphic.**

The Strategic Reinforcement of Europe (SRES) model was simple and understandable. Changes to the assumptions were readily discernible in the model output. Characteristics of the SRES model are shown in Figure 7-5. The model, written in standard FORTRAN IV, has been down-loaded to a PC. It uses an unclassified ship file. Presently it moves units in an aggregated manner. However, the ships which are moving each unit are identified so that units can be redeployed by notifying the ships to change their destination. It only takes about two minutes to run the model on a PC. This enables the analyst to make many iterations with data changes. For example, it took over 200 "what ifs" to finally get an acceptable solution to the 10 in 10 problem.

- RUNS ON PC
- FORTRAN IV PROGRAM
- USES SHIP FILE
- USES AGGREGATED VERSION OF TPFDD
- RUNS VERY QUICKLY AND IS SIMPLE TO MODIFY
- MANY WHAT IFS ARE POSSIBLE
- OVER 200 WHAT IFS TO CRACK 10 IN 10 PROBLEM

Figure 7-5. SRES Model Characteristics.

The final solution for the 10 in 10 problem required a number of assumptions as shown in Figure 7-6. Notice that since deterrence was the objective of this deployment, the ships were not unloaded. We did not examine the requirement to move the forces forward into the theater.

- PORTS - NOT SAME AS IN TPFDD
- SHIPS - USED FILE CONTAINING INDIVIDUAL SHIP DATA AND AVAILABILITY DATA; DIFFERENT FROM JOPES FILE AND AFPDA
- UNITS - AGGREGATED EQUIPMENT AND MOVED AS UNIT
- AIRCRAFT - ASSUMED AIRCRAFT AVAILABLE COULD BE CONCENTRATED
- DECISIONS - ASSUMED DECISIONS WERE MADE IN A TIMELY MANNER
- DETERENCE - SHIPS WERE NOT UNLOADED

Figure 7-6. Study Assumptions.

One result of the study has been a relook at the basic problem of moving 10 divisions to Europe in 10 days.

7.2 <u>IDA ROME STUDY</u>.

The Reception and Onward Movement Europe (ROME) study was conducted by IDA. It identified a number of problems such as timing, merging of equipment and personnel, shortages of resources, and the location of some of the merger points. The ROME study is not yet completed.

- PROBLEMS IDENTIFIED
  - TIMING
  - MERGING OF EQUIPMENT & PERSONNEL
  - SHORTAGE OF RESOURCES TO CONDUCT MERGER
  - LOCATION OF MERGER POINTS
- STUDY NOT COMPLETED
- POSSIBLE SOLUTION BEING CONSIDERED
- US ONLY STUDY

Figure 7-7. ROME Study.

Figure 7-8 illustrates graphically the area of concern for the IDA study.

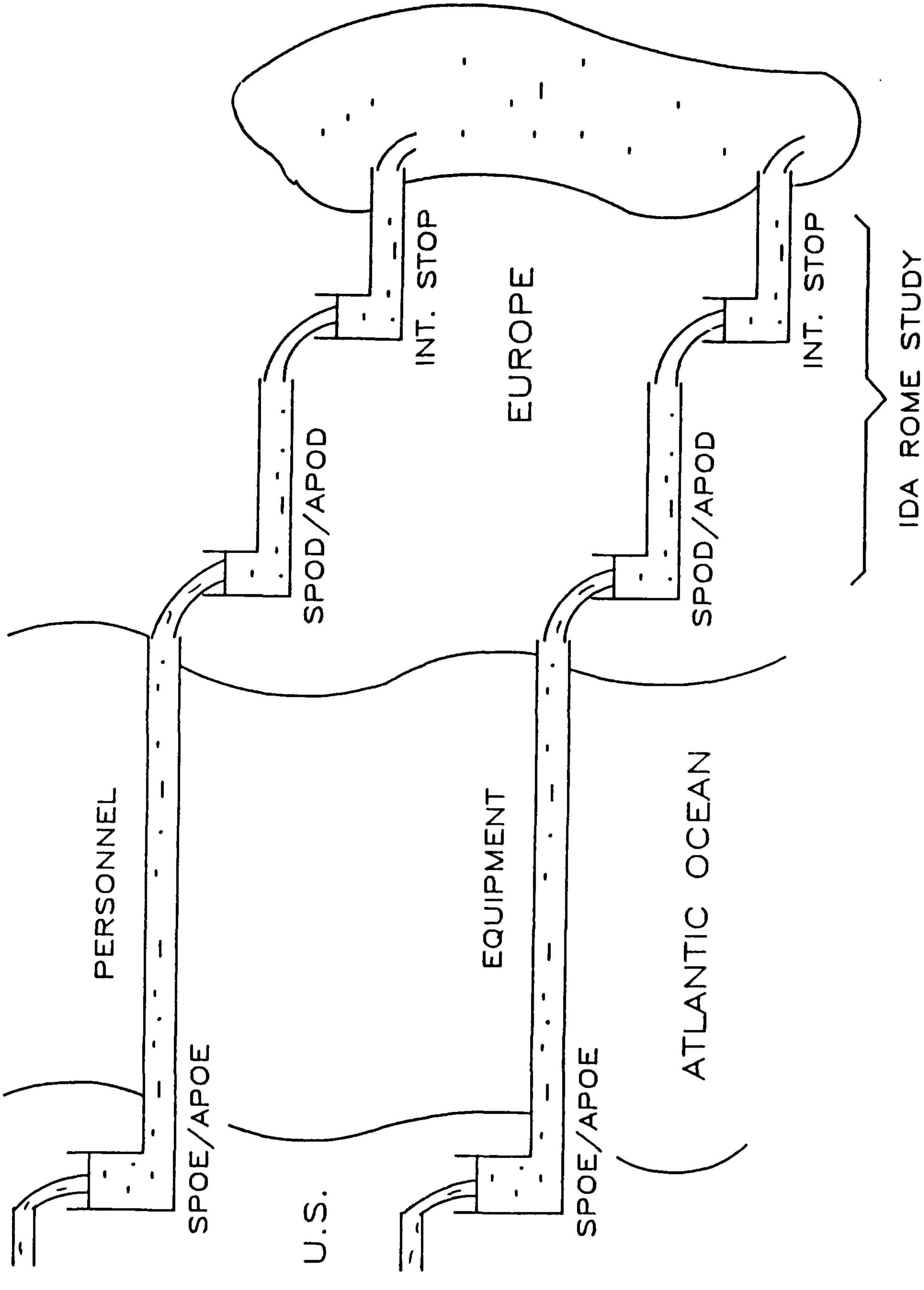



Figure 7-8. **ROME Study Graphic.**

SHAPE is also looking at the reception and onward movement problem. However, their studies shown in Figure 7-9 are related to strategic lift as well as the movement of all forces in Europe. The JRMS study is currently examining the feasibility of developing a communication system and database to facilitate this movement of forces and equipment.

- JUMP FAST PLAN
- RAPID REINFORCEMENT PLAN
- JRMS
- STUDIES ARE IN PROGRESS

Figure 7-9. SHAPE Studies.

Dr. Leake was educated in New York University where he received his BS, MS and PhD in mathematics. He has worked as an ORSA analyst since 1975 for DoD. Prior to that, he was an Assistant Professor of Mathematics at Wagner College, New York University, and Bronx Community College. He has worked at the US Army Armor and Engineer Boards, US Army Engineer School in Combat Developments, US Army Concepts Analysis Agency, and the USAREUR ORSA cell. He is presently a Principal Scientist at the SHAPE Technical Centre working on logistics problems.

# CHAPTER 8

# LINE HAUL TRANSPORTATION IN THEATER-LEVEL COMBAT SIMULATIONS

by CPT (P) Gregory P. Davis, USA

ABSTRACT: There are several approaches which can provide useful insight to decision makers on the adequacy of specific transportation functions and capabilities. However, the larger question is how much force structure should the Army dedicate to meeting the transportation requirements of the combat force. This question is addressed in the Total Army Analysis process through the conduct of theater-level combat simulations. The price that is paid for simulating operations at theater level is the loss of resolution in specific functions and processes. For the simulations conducted at CAA, we have decided that line haul movement is the only appropriate transportation function for modelling at theater level.

This presentation provides a methodology for modelling line haul transportation. It was developed as a solution to many of the problems encountered in modelling transportation in the Force Evaluation Model (FORCEM). The resolution of significant problems such as the accurate representation of line haul transportation capability and the process by which capability is appropriately applied to requirements is explained in detail.

## 8.0 PRESENTATION OUTLINE.

I - Background

II - Challenges and Solutions

## 8.1 BACKGROUND.

The Force Evaluation Model (FORCEM) (Figure 8-1) which is under development at the Concepts Analysis Agency (CAA) under the Army Model Improvement Program will be the Army's theater-level combat model. The representation of combat in FORCEM will be a vast improvement over the other theater-level models to include the Concepts Evaluation Model (CEM) which is currently used at CAA. The most noteworthy improvement, and the greatest challenge, is providing enough resolution of combat support and combat service support to allow analyst to gain insights into the capability of the force to sustain combat.

Figure 8-2 shows the highlights of the development history of FORCEM. Basic model design and development began in 1982. By 1985, operational testing was underway which included the model's use for the annual Omnibus evaluation of Army capability as a demonstration. Subsequent years have brought emphasis on improving fidelity in combat and support operations. We are now involved in a model improvement program designed to correct identified deficiencies and add important new capabilities.

- **'82 - '84:** BASIC MODEL DESIGN & DEVELOPMENT
- **'85:** OPERATIONAL TESTING & DEBUGGING
  OMNIBUS 85 AFCENT FIGHT (DEMONSTRATION)
- **'86:** COMBAT OPERATION FIDELITY
  OMNIBUS 86 AFCENT FIGHT
- **'87:** SUPPORT OPERATIONS FIDELITY
  C-SRS AFCENT FIGHT
- **'88:** MODEL IMPROVEMENT PROGRAM INITIATION
  OMNIBUS '89 FIGHT
  4102 FIGHT

Figure 8-2. FORCEM History.

The Army Model Improvement Program (AMIP) is a major undertaking of the 1980's to develop a complete integrated family of combat simulations. Models representing three levels of resolution are being developed to satisfy diverse analytical needs of the Army (Figure 8-3). The higher resolution models will provide combat results to the lower resolution models and receive, in turn, scenario conditions.

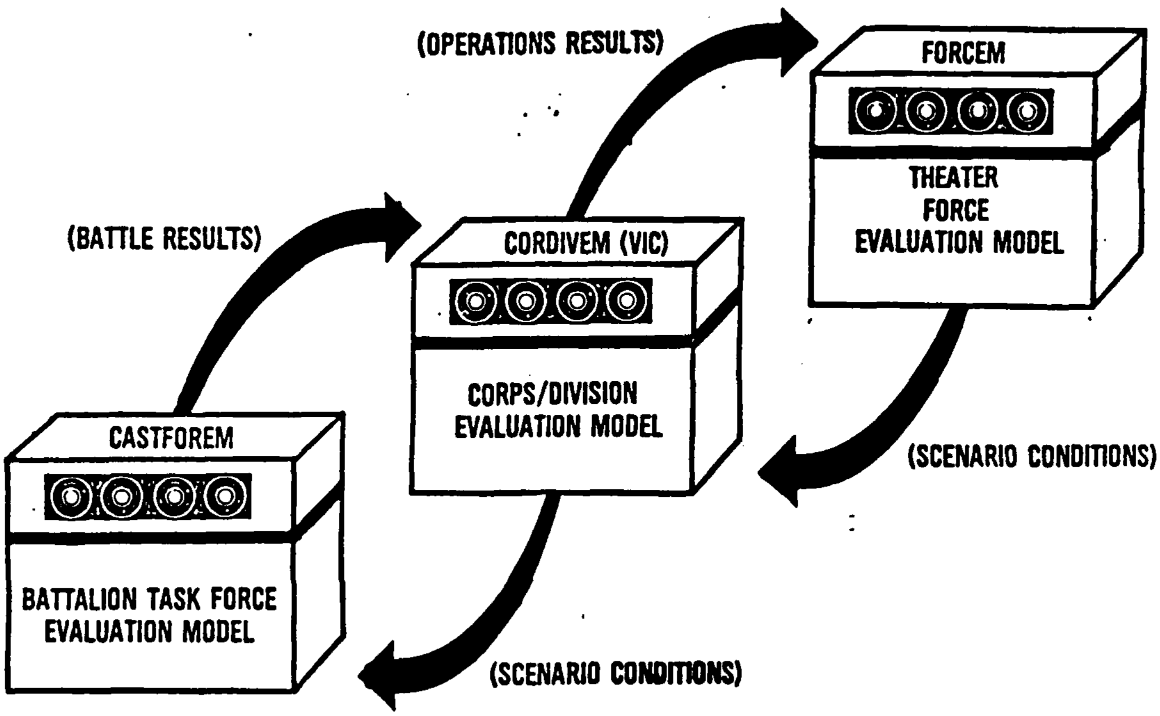



Figure 8-3. FORCEM is a Member of a Family of Models.

Figure 8-4 provides an overview of the FORCEM model. Data on the U.S. force, its deployment schedule, and the threat are input to a unit status module. Command and Control ($C^2$) decisions, under the operational control of the model user, result in a combat situation.

A division-level combat simulation, currently the Combat Sample Generator (COSAGE), is run to generate a library of consumption, equipment, and personnel loss data for FORSEM. Combat is resolved using the division combat library developed with COSAGE. The air war resolution includes representation of Close Air Support (CAS), Battlefield Air Interdiction (BAI), Suppression of Enemy Air Defense (SEAD), Deep Interdiction, and Combat Air Patrol missions as well as the air defense battle.

This phase provides data on force movement, casualties, losses, and consumption which are provided to the FASTALS model for computation of nondivisional support requirements. They are also provided to a combat service support (CSS) module where personnel and equipment pools are maintained and medical, supply, maintenance, and transportation functions are represented. This module provides an update to the unit status for the next iteration of combat resolution.

Transportation is represented in FORCEM as a means to provide POL, ammunition, major end items, repair parts, and personnel from in-theater ports of debarkation (PODs) forward to army, corps, and division support units. POL pipelines, railroads, barges, and truck movement are represented (Figure 8-5).

As shown in Figure 8-6, FORCEM represents all key ground and Air Force elements in combat, and all key ground force CSS functions. Status of major systems are maintained to include the presence of crew personnel, ammunition, and POL necessary to make them effective in combat. Other support requirements are calculated in FASTALS based upon movement and losses in the combat modules.

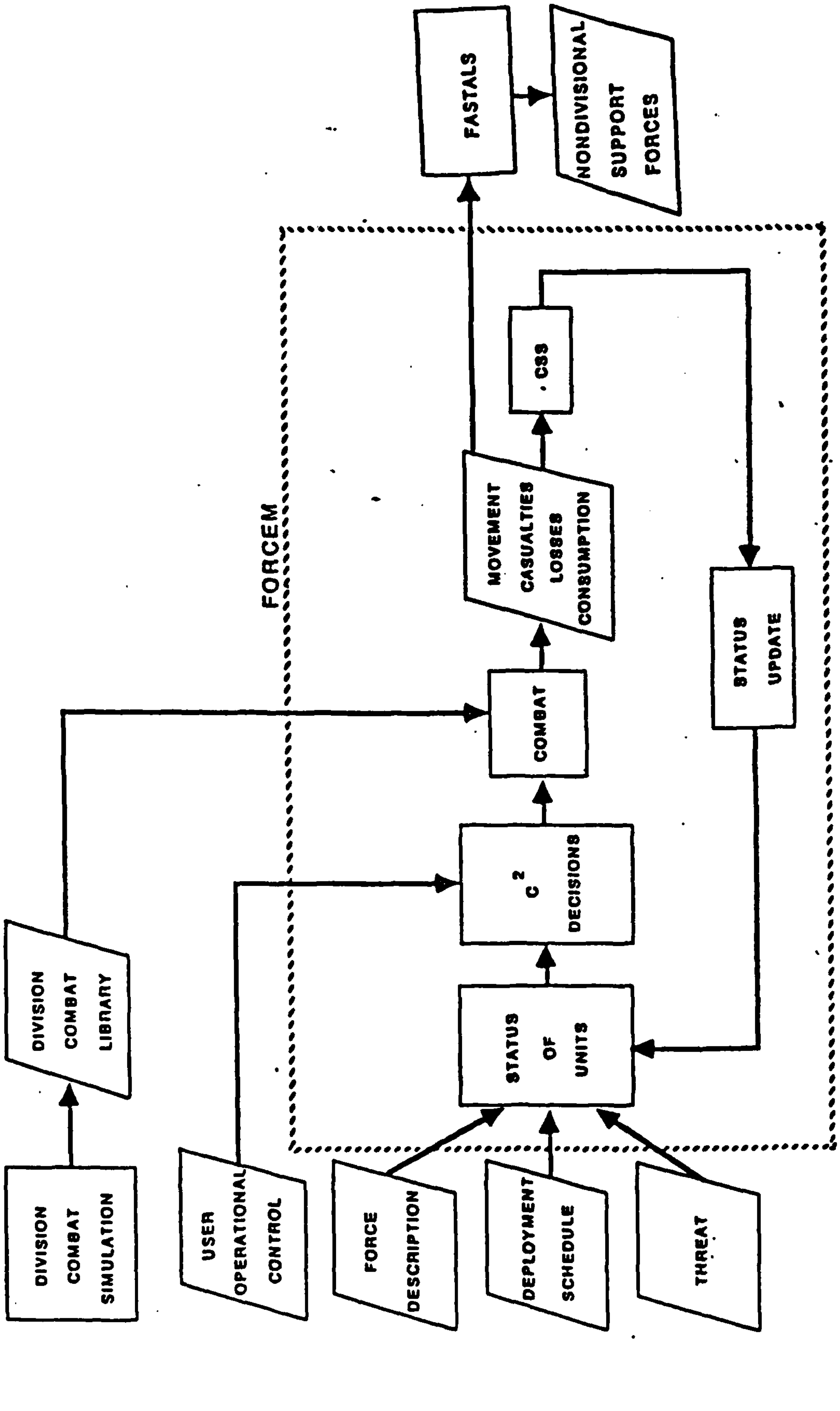



Figure 8-4. FORCEM Overview.

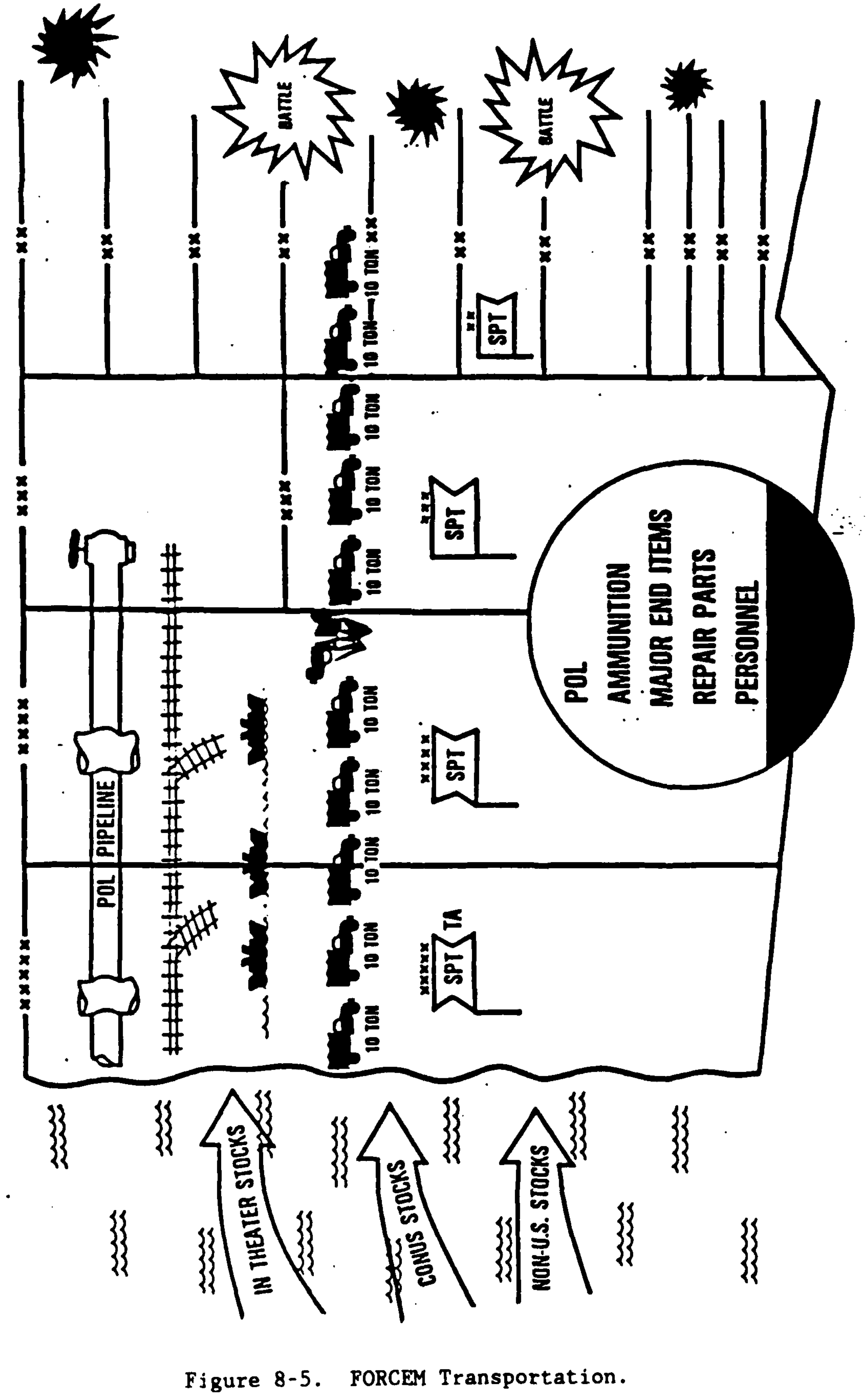



Figure 8-5. FORCEM Transportation.

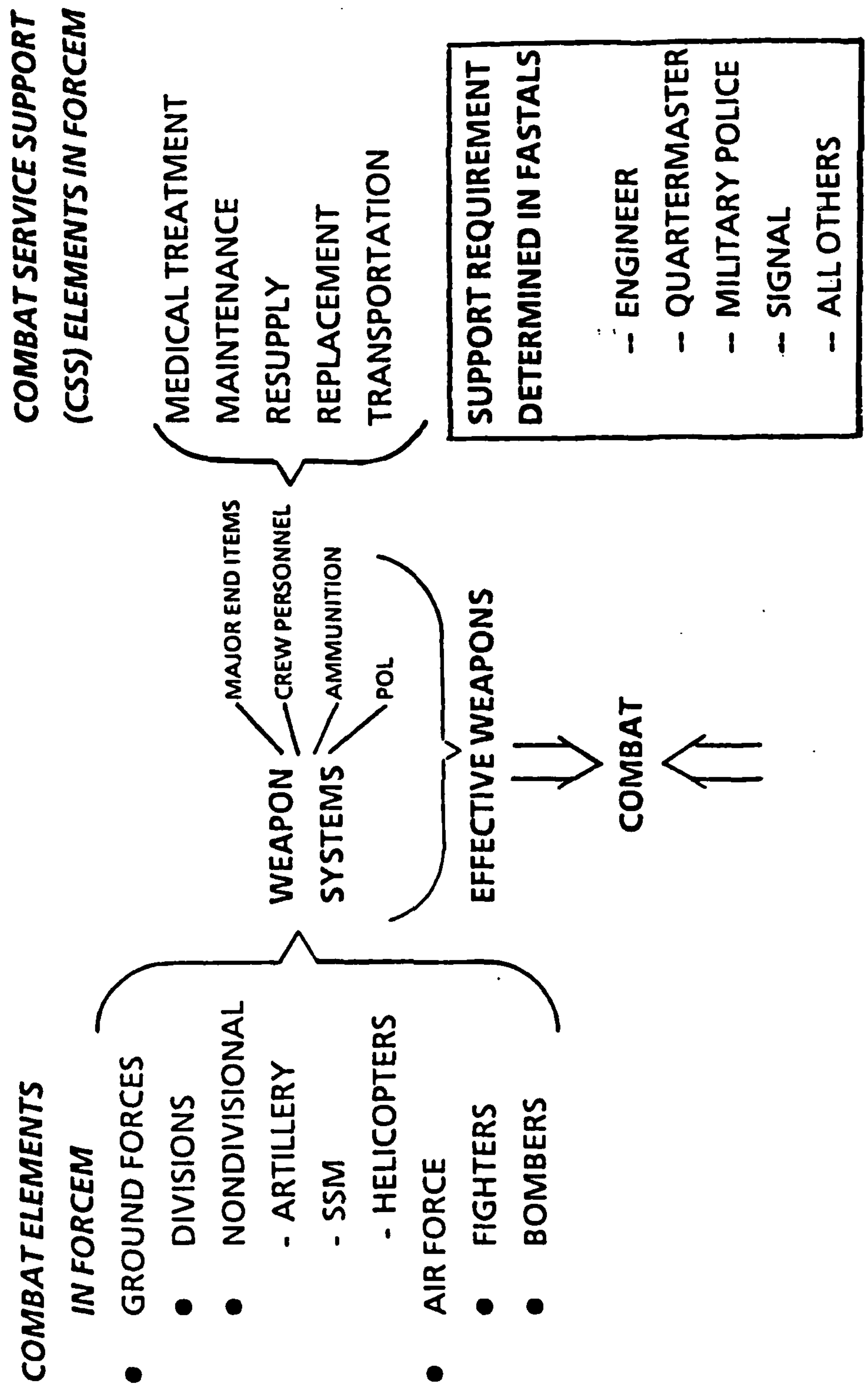



Figure 8-6. Representation in FORCEM.

## 8.2 CHALLENGES AND SOLUTIONS.

Inherent in any theater-level simulation is a certain lack of resolution of events and systems that are not the main orientation of the model. Such is the case with the representation of the transportation system in the theater-level combat simulation. Transportation is undisputable the lifeline of US combat units. However, it is extremely difficult at best for a model designed to represent combat to achieve a reasonable representation of the transportation system operating in support.

Contained in this paper is the result of my effort to design an algorithm which will provide a reasonable representation of the effects of the transportation system on combat in FORCEM. After a great deal of coordination with senior transporters, force structure analysts and modellers, I settled on the line haul facet as the most effective means of representing theater-level transportation. Thus, the thrust of the design effort was on representing the doctrinal employment of line haul medium truck companies. The algorithm as represented in this paper is the foundation for future developments which will ultimately provide critical insights into the functions and capabilities of the transportation system during combat. Three aspects of line haul transportation were deemed to be the most critical for establishing a sound foundation. Those are shown in Figure 8-7 and are discussed in more detail in the remaining part of this presentation.

- **ALLOCATION OF WORKLOADS TO MODES OF TRANSPORT**
- **REPRESENTATION OF LINE HAUL CAPABILITY AND WORKLOADS**
- **REPRESENTATION OF EVENTS THAT IMPACT ON LINE HAUL CAPABILITY**

Figure 8-7. The Challenges.

The first challenge is how to allocate workloads to modes of transport (Figure 8-8). FORCEM uses transportation mode distribution data that is provided to CAA by USAREUR. This data is in the form of a table that designates the projected amount of a particular commodity to be moved (as a percent of the total amount of that commodity to be moved) by the available modes of transport to a destination echelon (corps, division, etc.) in addition to a commodity priority array. When a workload is generated (cargo requiring movement from one echelon to another), the model selects the proper allocation of transport modes from the percent of movement table based on the destination echelon and the type of cargo. For example, it selects the input percentages of each shipment of ammunition from Army to Corps SUPCOM to be shipped via rail, truck, and barge, respectively. While building the convoys, a selected mode of transport may not be available. In this case the model would use the priority array to select the next preferred mode.

Consider the following example (Figure 8-9). Workload has been generated that requires 1000 short tons (stons) of ammunition to be moved from the US Army Support Command to the VII Corps Support Command. From the percent of movement array, the model would attempt to allocate the workload as 60% by rail (600 stons) and 40% by truck (400 stons). Since the model does not currently represent intratheater air as a mode of transport, the airlift workload (5%) was allocated to highway. The priority array provides rail as the preferred mode of transport for ammunition and highway as the alternate means. Therefore, if the rail capacity is exhausted before the 600 st of ammunition can be assigned to a rail convoy, the remainder would be allocated to highway transport and assigned to a truck convoy for movement from the Army to the VII Corps. If truck transportation is not available, the ammunition would be held until assets became available.

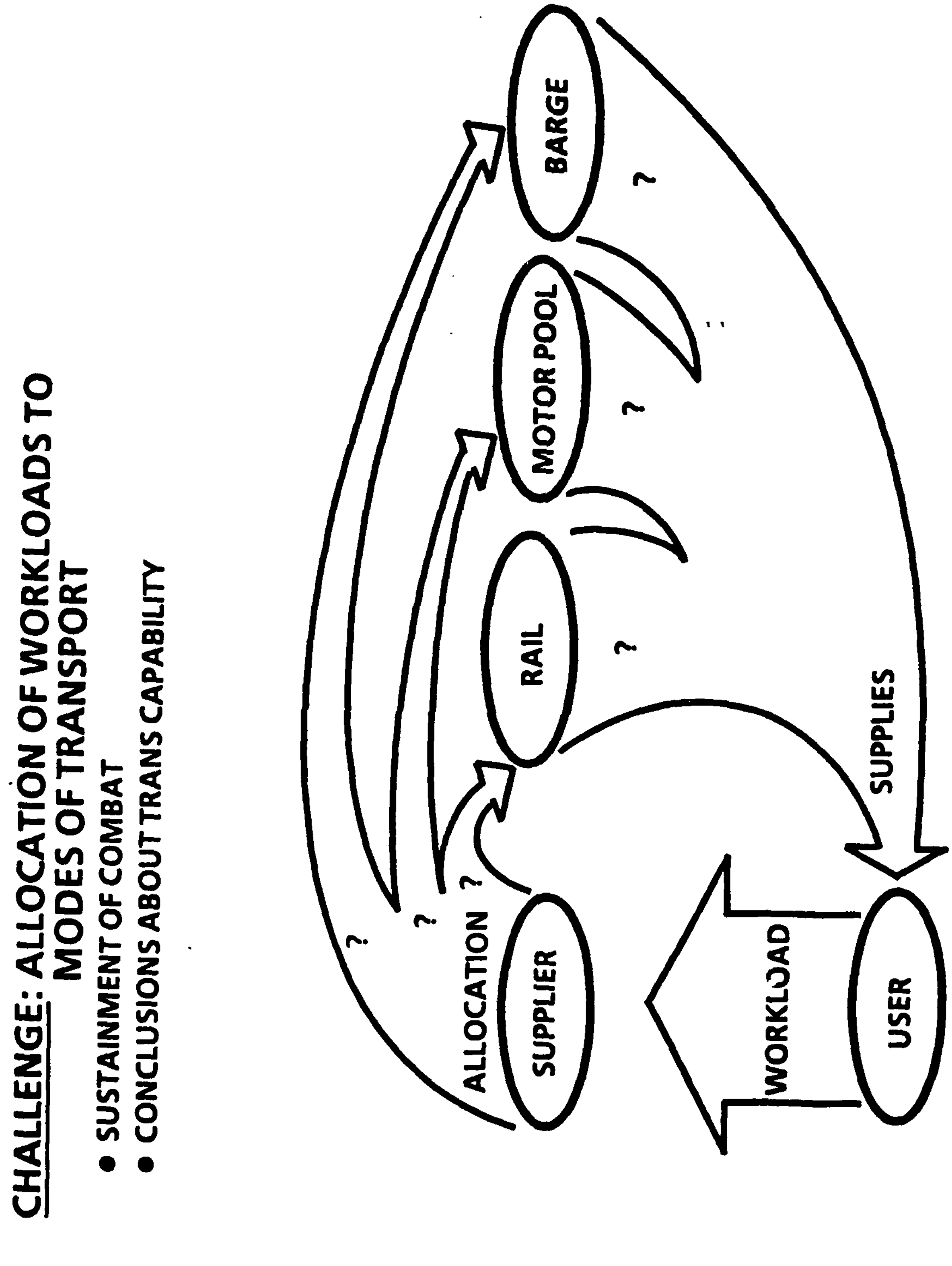



Figure 8-8. Challenge: Allocation of Workloads to Modes of Transport.

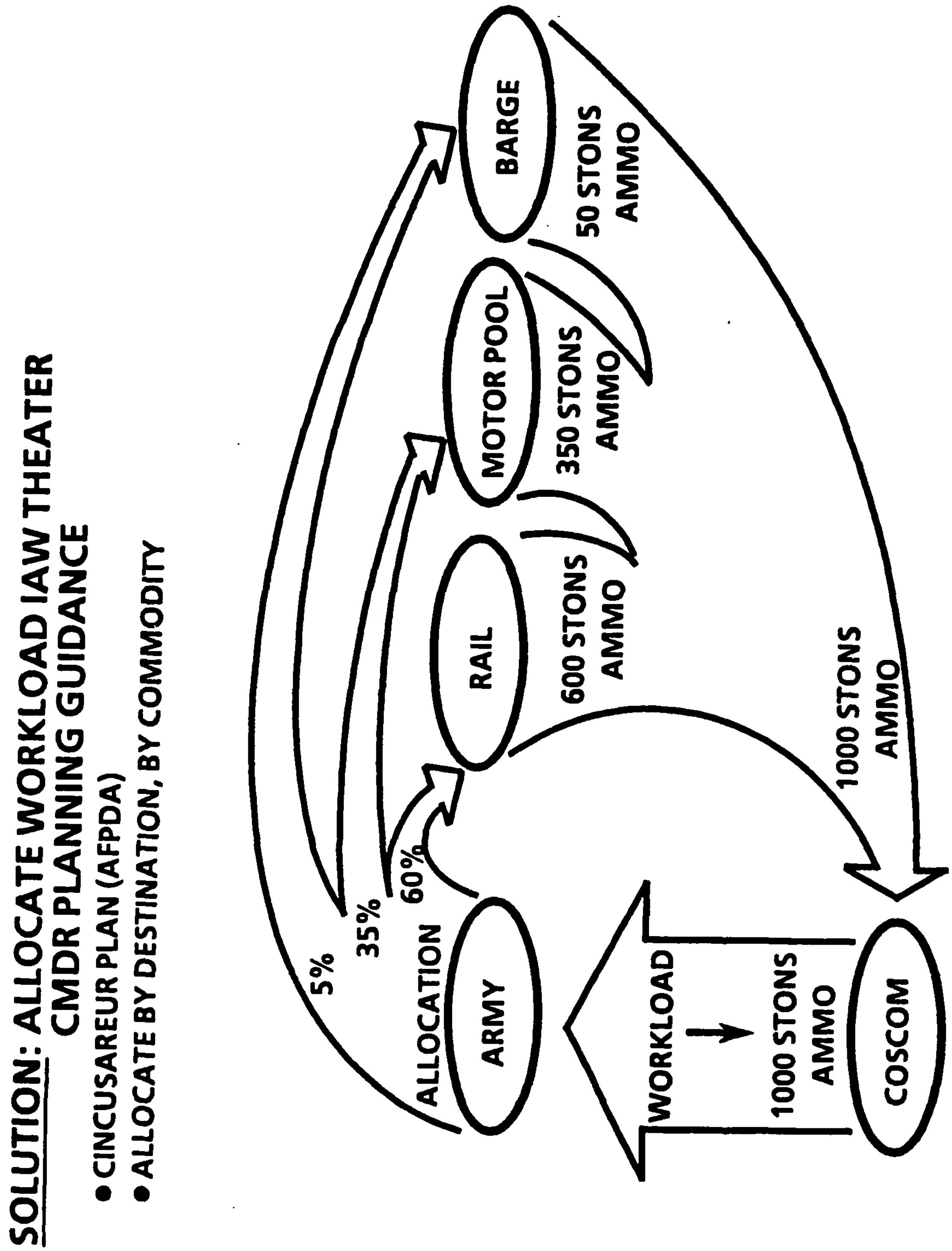



Figure 8-9. Solution: Allocate Workload IAW Theater Commander Planning Guidance.

The second challenge is how to represent line haul capabilities and workloads of transportation units (Figure 8-10). The TOE capability of a medium truck company is the amount of cargo or POL that can be transported by that unit from origin to destination per day (20 hours). The unit is structured to accomplish this in two round trips (one per 10 hour shift) per day. Note from Figure 8-11 that transporting from army to corps SUPCOM and from corps to division SUPCOM exceeds the range of a medium truck company (i.e., the unit can not accomplish two round trips in 20 hours). In reality, at least two companies would cover this distance through the use of one or more trailer transfer points.

The solution to this problem is shown in Figure 8-12. Since FORCEM does not represent trailer transfer points a unit assigned to the Army SUPCOM will cover the entire distance to the corps. This results in an overstatement of the capability of the unit. This problem can be solved by expressing the line haul capacity and the workload in short ton hours. Short ton hours is the product of the distance by road (in miles) and the time (in hours) required for a truck company to accomplish a workload. Utilizing the data from Figure 8-12, input to the model by the user, the 1000 stons of workload requiring movement from corps to division SUPCOM would be converted to short ton hours of line haul cabalility as follows:

| workload (stons) | | time and distance factor | | workload (ston hrs) |
|---|---|---|---|---|
| 1000 | X | 10.33 | = | 10330 |

Note: POL must be handled separately from dry cargo. POL workloads are converted from gallons to short tons and allocated against POL transport capability.

The capacity of a particular type of medium truck company (scr 55018H610) is converted to short ton hours as follows:

| avail vehicles per day | | capacity per veh | | hours of work per day | | total capacity of src (ston hrs) |
|---|---|---|---|---|---|---|
| 45 | X | 22 | X | 20 | = | 19800 |

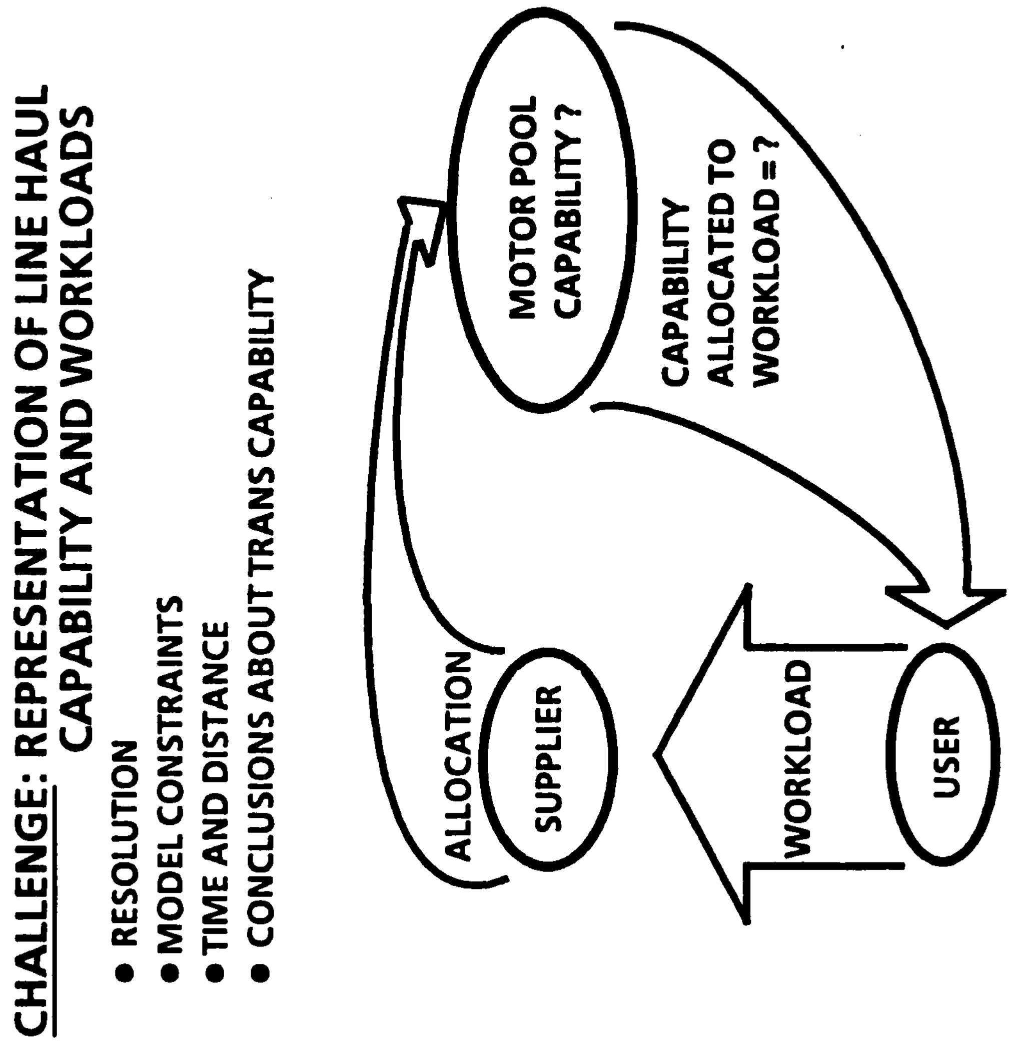



Figure 8-10. Challenge: Representation of Line Haul Capability and Workloads.

The workload of 10330 short ton hours is then deducted from the 19800 short ton hours of capability at the corps. The remaining 9470 short ton hours is available for other workloads for that day.

Note that capability must be allocated to the workload for 24 hours. This is essential because the representation of line haul transportation in this algorithm is based on the amount of workload that can be accomplished by a unit in one day. Therefore, capability that has been allocated to a workload can not be reallocated until the following day.

| TRANSPORT TIME BY ECHELON (HOURS) | | | |
|---|---|---|---|
| ECHELON | DISTANCE (one way) | MVMT RATE (miles/hr) | RND TRIP TIME (hours) |
| PORT to Theater SUPCOM | 100 | 25 | 8.00 |
| THEATER to Army SUPCOM | 105 | 24 | 8.75 |
| ARMY to Corps SUPCOM | 151 | 18 | 16.78 |
| CORPS to Division SUPCOM | 62 | 12 | 10.33 |

NOTE: Distances and movement rates are extracted from the road network of the FASTALS model.

Figure 8-11. Typical Line Haul Distances and Movement Rates.

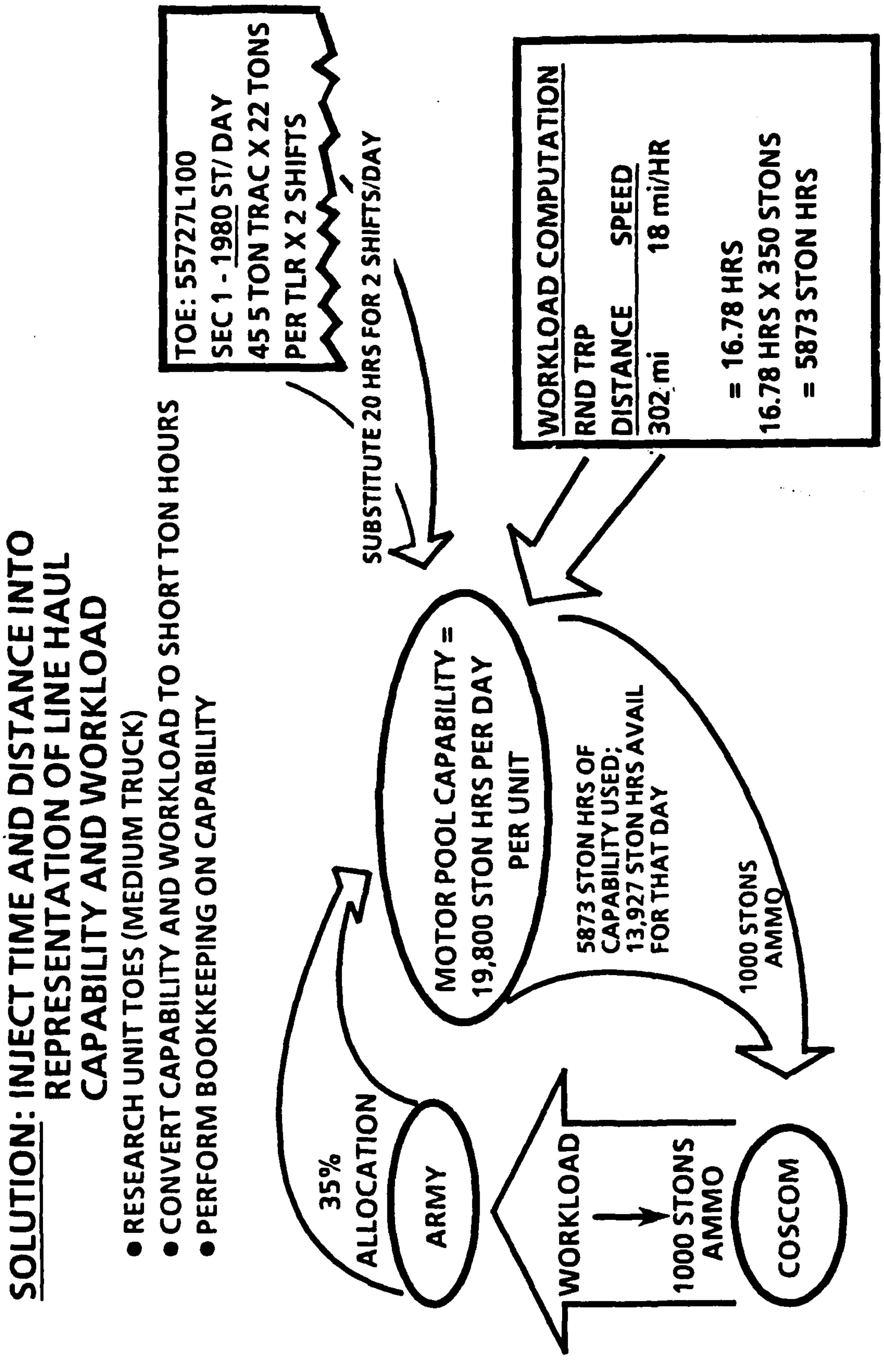



Figure 8-12. Solution: Inject Time and Distance Into Representation of Line Haul Capability and Workload.

The third challenge is to represent events that impact on line haul capability (Figure 8-13). FORCEM will have the capability to strike trucks in motorpools and in convoy and thereby subject them to attrition and damage. To utilize the truck attrition and maintenance data, the model must have a truck as opposed to a short ton hour.

The solution to this challenge is shown in Figure 8-14. The requirement to represent trucks instead of workload in FORCEM can be met by a simple conversion that would be accomplished prior to the routine that creates convoys. Utilizing the previous example:

| workload (ston hrs) | | total avail capability (ston hrs) | | utility |
|---|---|---|---|---|
| 10330 | - | 19800 | = | 52 % |

The total available capability is a representation of 45 5-ton tractors. Therefore, 52% of 45 (i.e., 24) trucks would be the size of the convoy required to complete the movement to that destination for that day. These 24 trucks would then be subject to attrition by FORCEM combat. The available truck capability would have to be computed for each support command every 24 hours after the beginning of combat based on the remaining trucks after attrition. For example, if two of the trucks were destroyed, the new capability would be 43 x 22 x 20 = 18920 short ton hours for the following day. The trucks would become a quantifiable entity in the model and subject to more realistic attrition. Moreover, trucks would then be subject to maintenance in FORCEM similar to tanks and other tracked systems.

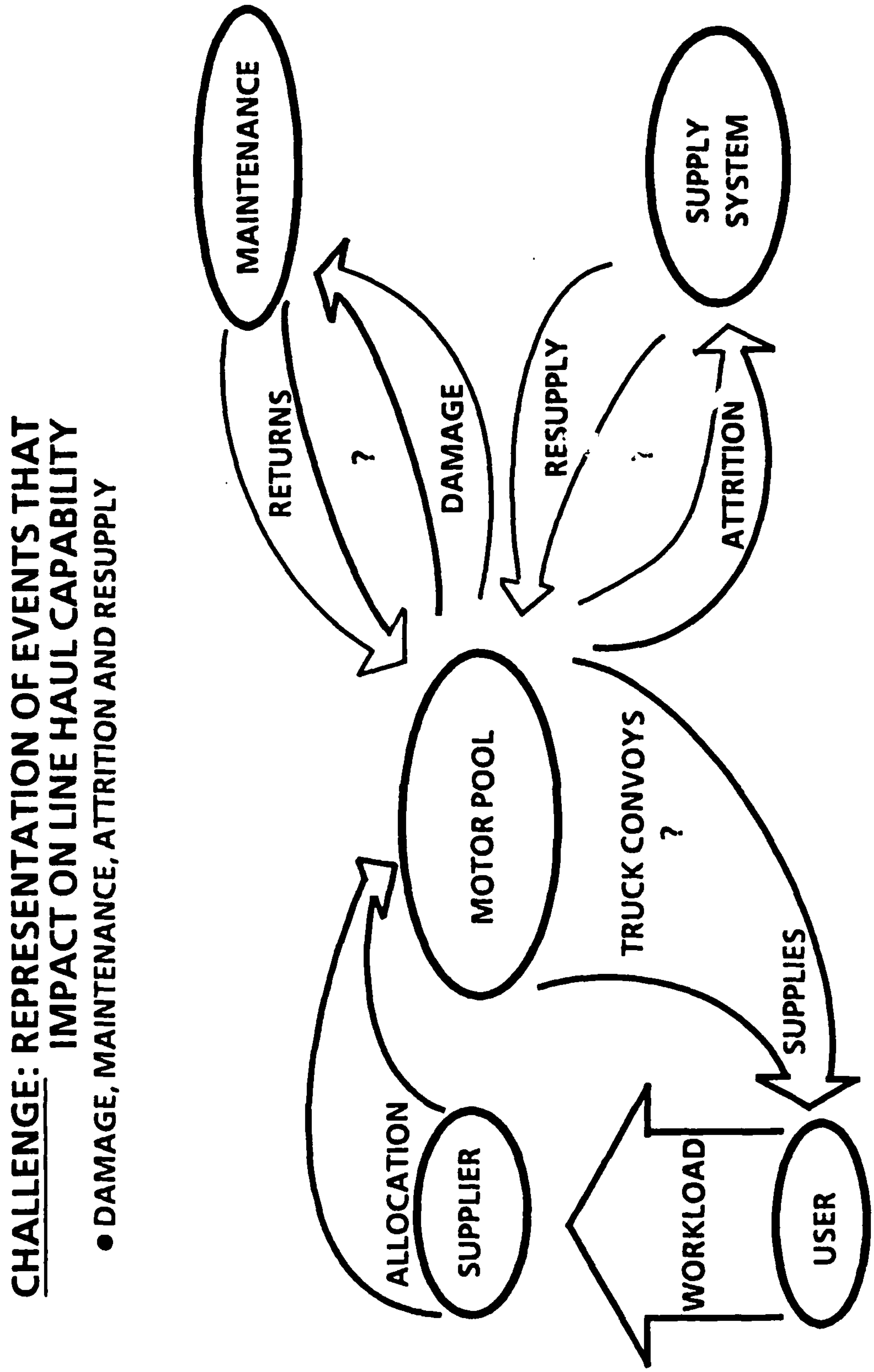



Figure 8-13. Challenge: Representation of Events That Impact on Line Haul Capability.

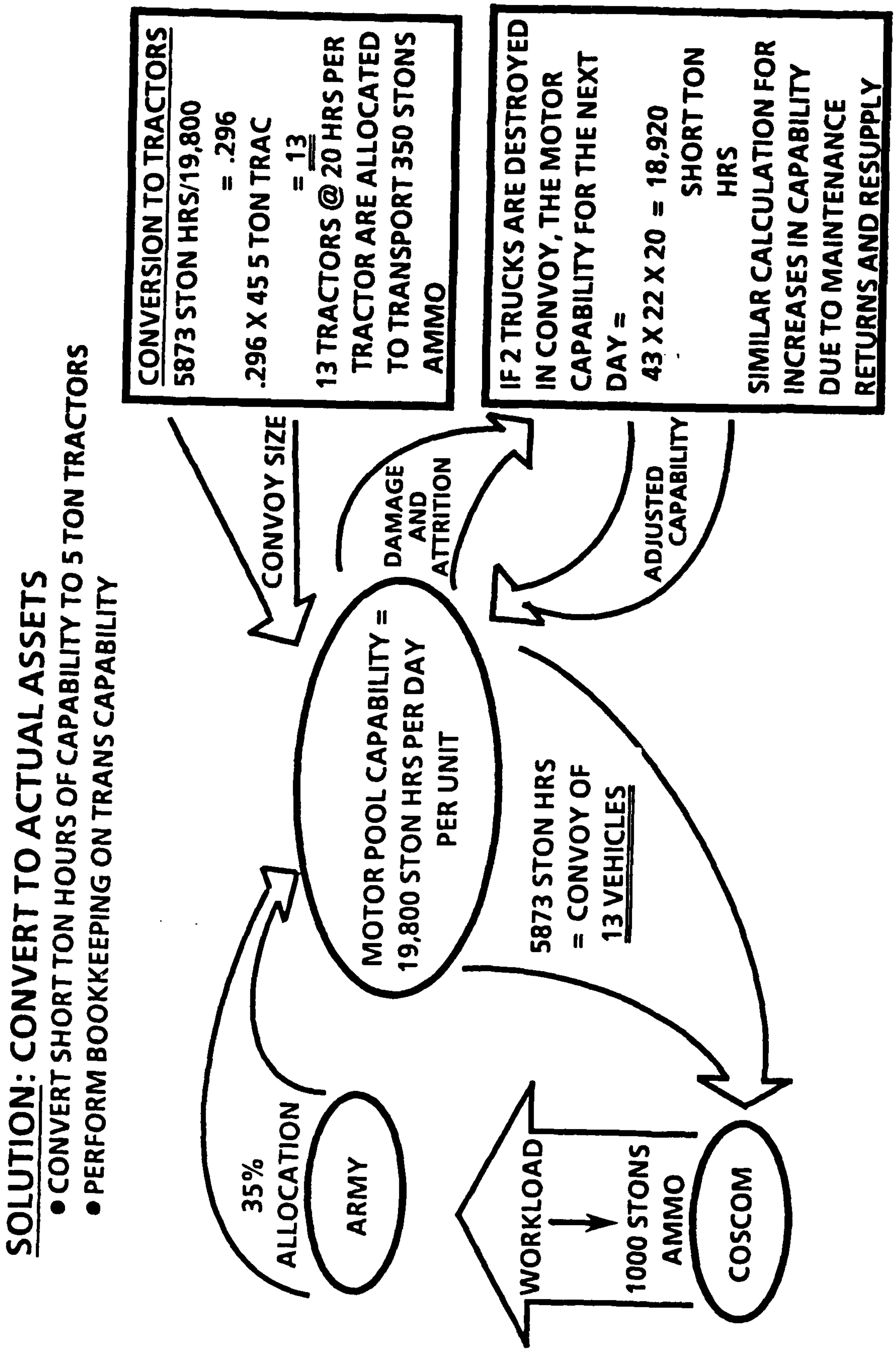



Figure 8-14. Solution: Convert to Actual Assets.

An effective analysis of transportation will be an essential requirement for the successful completion of all future studies utilizing FORCEM. Incorporation of these algorithms into the model will yield results that will provide an analyst with valuable information with which to make force structure and related decisions about transportation capability in theater-level analyses.

CPT Davis is a Virginia Tech graduate with a Masters in Business Management from Troy State and has also graduated from the Army's ORSA Military Applications Course. He is a Transportation Corps officer with service in the MTMC in Europe, and recent Company Command at Fort Eustis, Virginia. He is currently assigned to the CAA's Theater Operations Center.

CHAPTER 9

# TACTICAL MOBILITY: A CORPS-LEVEL PERSPECTIVE

by CW3 Larry G. Haynes, USA

ABSTRACT: Vector in Commander-Combat Service Support (VIC-CSS) simulates combat, combat support, and combat service support operations at Corps level. CSS activities portrayed in VIC-CSS are resupply on both the wholesale and retail levels and the recovery, evacuation, repair, and return to duty of battle damaged and failed weapon systems and soldiers for both RED and BLUE forces. Transportation assets portrayed in the model for these activities include tracked vehicles, trucks, aircraft (both fixed and rotary wing), rail, and pipeline. With the exception of pipelines, all of these assets may be gamed explicitly and be subject to combat damage and reliability failures. Supplies move from rear to forward supply points by either pipeline, rail, or truck convoy. Supplies move from forward supply points to maneuver units by either aircraft or truck.

Analysis of VIC-CSS output, with respect to those parameters which represent the transportation system, provide an indication of how the transportation system performed during the simulated battle. The analyst may examine both the effects of combat on the transportation system and the effects of the transportation system on the outcome of the battle. If a more detailed analysis of the transportation system is required, the VIC-CSS output can be used as input to higher resolution, function-specific models.

## 9.0 PRESENTATION OUTLINE.

I - VIC-CSS Design

II - VIC-CSS Features

III - VIC-CSS Output

## 9.1 VIC-CSS DESIGN.

The Vector In Commander-Combat Service Support (VIC-CSS) model is a deterministic, discrete event model which simulates combat, combat support, and combat service support operations at corps level. For the most part, units and their activities are portrayed at a battalion level resolution. The model is written in the SIMSCRIPT II.5 simulation language.

CSS activities portrayed in VIC-CSS (Figure 9-1) are resupply on both the wholesale and retail levels and the recovery, evacuation, repair, and reissue of battle damaged and failed weapon systems and soldiers for both RED and BLUE forces. Both the supply and return to duty modules employ transportation assets.

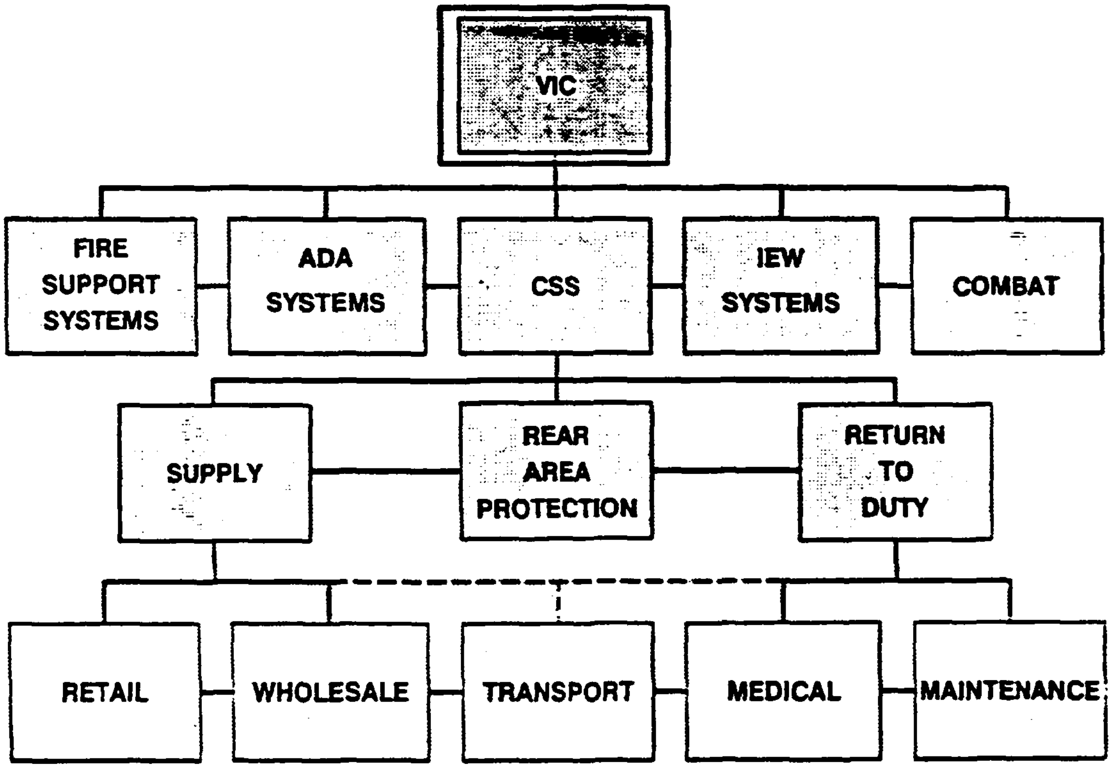



Figure 9-1. VIC-CSS Design.

The transportation activities in VIC-CSS (Figure 9-2) include both explicit and implicit movement. While traveling explicitly, vehicles are subject to enemy interdiction; those traveling implicitly are not.

Vehicles which travel explicitly include supply convoys and aircraft on emergency resupply missions. The supply convoys travel on a user-defined road network and are affected by traffic congestion.

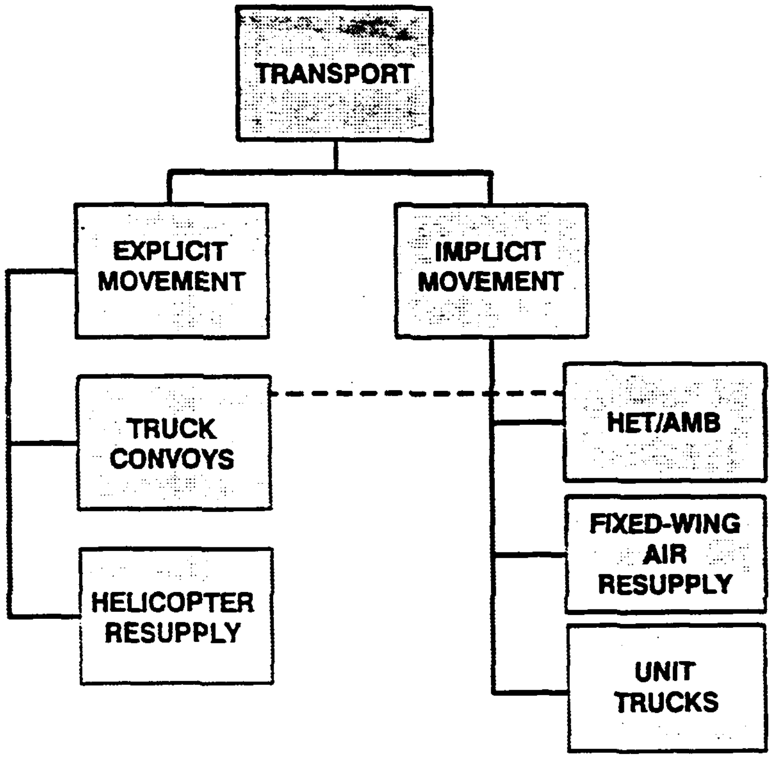



Figure 9-2. Transportation Design.

Those which travel implicitly include recovery and evacuation vehicles, aircraft on preplanned resupply missions and maneuver unit resupply vehicles. Ground evacuation vehicles use the supply road network to compute their trip time with current traffic conditions taken into consideration. Travel time for recovery vehicles and air evacuation vehicles is an input data item. Travel time for unit resupply vehicles is determined by the current distance between the units and the supply point.

As shown in Figure 9-3, the maintenance and medical systems have three requirements for transportation: recovery from the battlefield, evacuation to higher echelons, and return for reissue. Assets for each of these transportation requirements may be gamed either implicitly or explicitly. Battle damaged and RAM failed weapons and personnel fall into a user defined distribution of damage levels. For each weapon category, at each applicable damage level, the type of recovery and evacuation vehicle to be used is specified in the input data. If recovery or

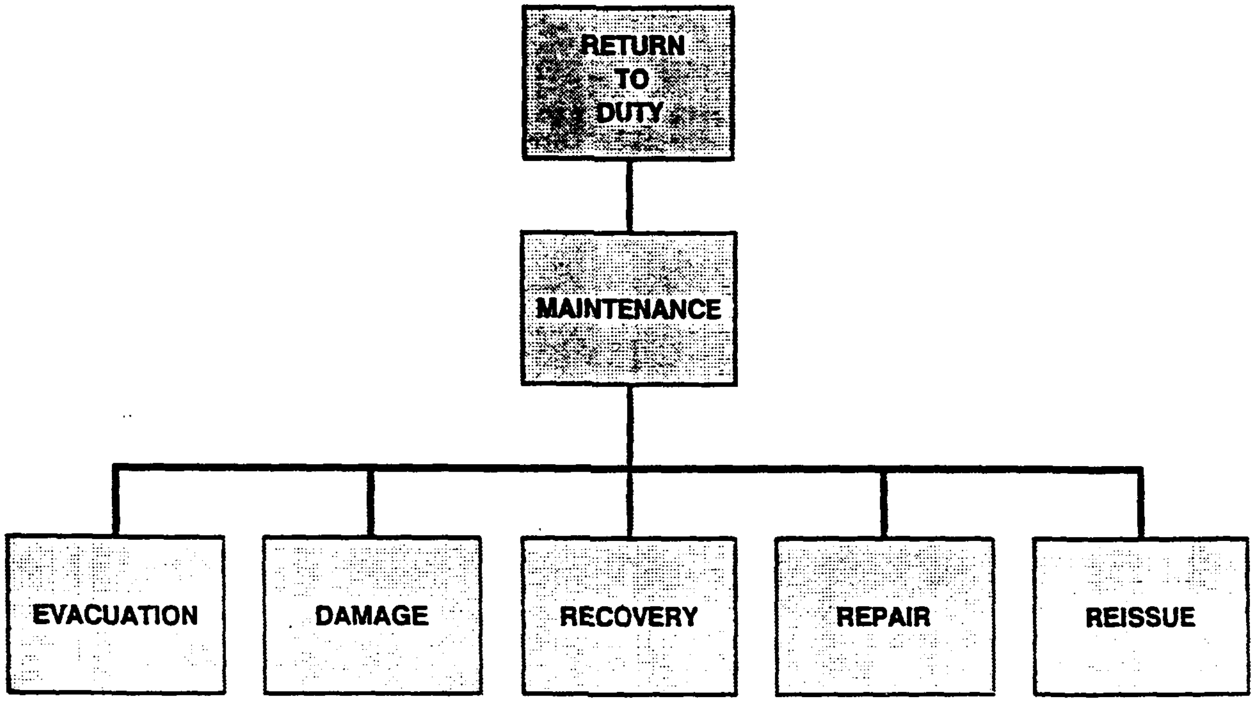



Figure 9-3. Maintenance Design.

evacuation of a weapon category at a particular damage level is to be performed by a recovery or evacuation asset which is not explicitly gamed, then self-recovery or self-evacuation is specified for that weapon category and damage level. Each recovery vehicle played must have input data specifying the percent of time it will be available for recovery work and, for each weapon category which it can recover, the quantity of that weapon category which it can recover simultaneously and the time required to perform that recovery. The availability factor should include such things as crew rest and the use of the recovery vehicle for work other than recovery (e.g., using the lift capability of an M88 for pulling power packs from tanks). Each evacuation vehicle played requires the same data as do recovery vehicles as well as identification of whether the evacuation vehicle is an air or ground asset.

## 9.2 VIC-CSS FEATURES.

As weapon systems and personnel suffer RAM failure or are damaged by enemy action, they either self-recover or are placed into recovery queues (Figure 9-4). Those which self-recover go into the repair queue if they

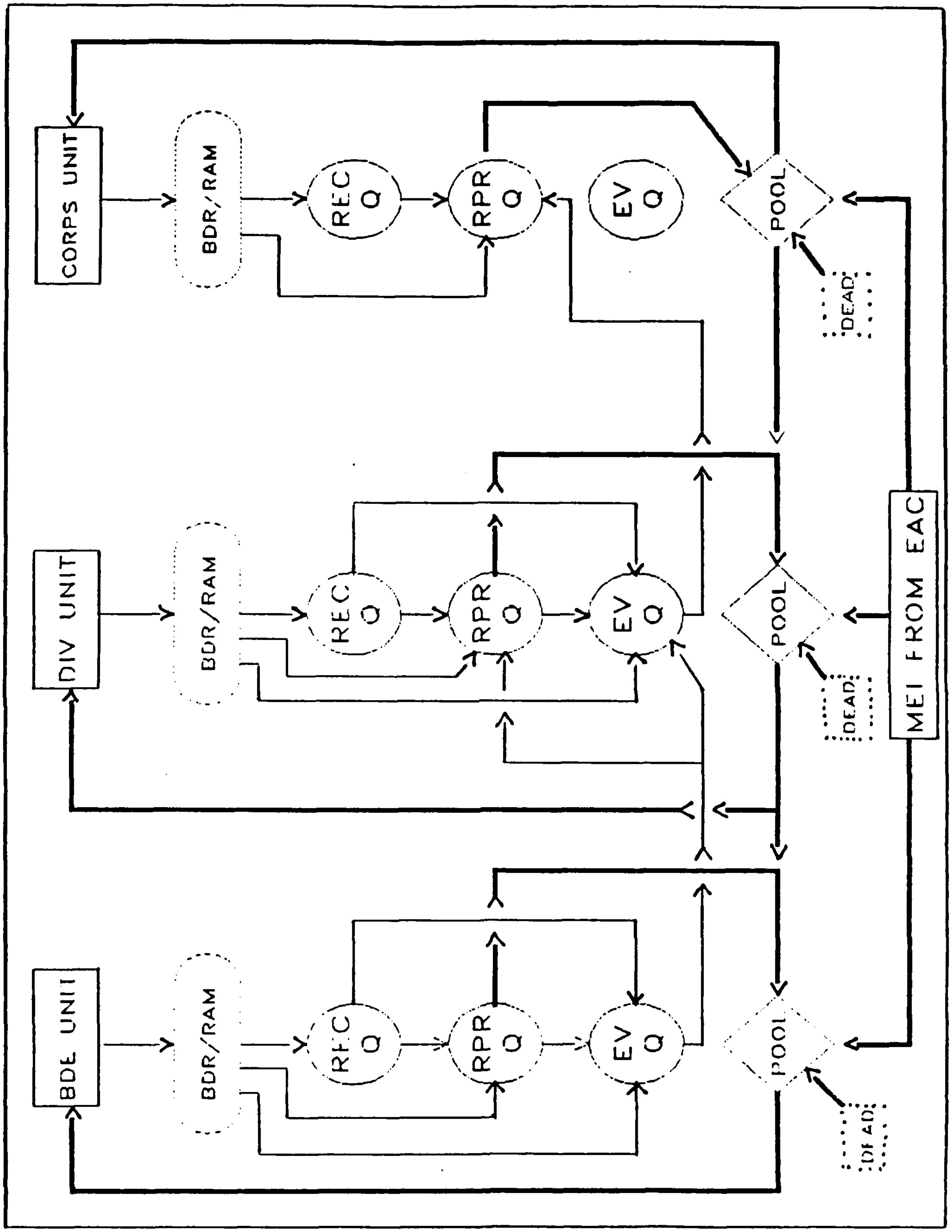



Figure 9-4. Maintenance System.

are to be repaired here, or into an evacuation queue if they are to be repaired at a higher echelon. On a cyclic interval (usually 15 minutes), each maintenance unit looks at each of its recovery queues and computes the number of recoveries performed during that cycle as the minimum of the number required and number possible. If more recoveries are required than possible, an equal percentage of each weapon type is recovered. There is no prioritization between weapon types for recovery. The appropriate numbers of each weapon type are then transferred from recovery queues to repair and evacuation queues. Evacuations are computed exactly like recoveries with the exception that while recovery times are input data, the time required to perform ground evacuations is computed based on the current traffic conditions on the road network.

Repairs are computed somewhat similarly to recoveries and evacuations, although on a separate (and usually much longer) cycle. As weapons are repaired, they are transferred into reserve pools for reissue. Reissue of weapons and personnel to maneuver units is performed on the same cycle as repairs. Crew served weapons may be issued to units only if crews are available either at the unit or in a personnel pool.

As evacuations are performed, repaired weapons are carried down to lower echelon maintenance units using the same evacuation assets for return as is required for evacuation of each weapon type. Weapon systems which self-evacuate, as well as personnel of all categories, are allowed to self-return. Recall that self-evacuation actually means evacuation without the use of an explicitly gamed evacuation asset; self-return carries the same implication.

Major End Items (MEI) coming into the corps and weapon systems salvaged from "killed" units are implicitly transported.

The wholesale supply system (Figure 9-5) transports supplies from rear to forward supply points by either truck convoy, pipeline, or rail. Supplies move from forward supply points to maneuver units either by truck or by aircraft, depending on the urgency of need and whether the unit is on the friendly or enemy side of the FEBA. All supply types in VIC-CSS belong to one of three categories: ammunition, fuel, and "other". The "other" category includes any supply type which is not explicitly gamed. Its role is merely to place a load on the transportation system. Each supply truck may carry only one category of supply, but aircraft and rail shipments may contain any combination of supply categories.

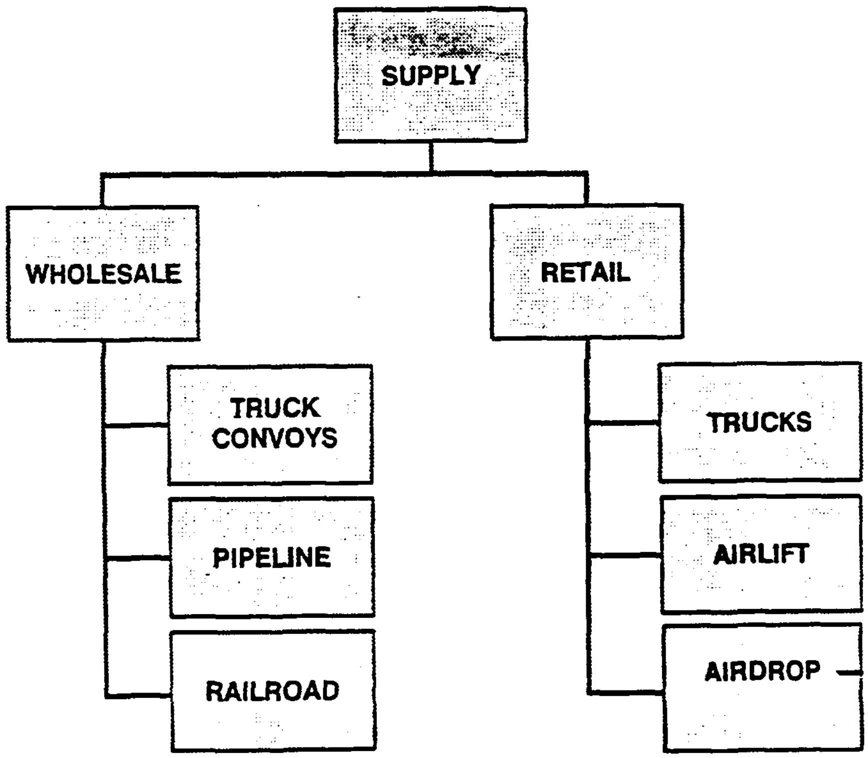



Figure 9-5. Supply Overview.

Illustrated in Figure 9-6, as units expend ammunition and fuel, their stockage levels are continuously updated and the need for reorder is monitored. Once a unit determines a need to reorder, the mode of transport must be determined. If the unit is on the enemy side of the FEBA, then all resupply must be by air. If the unit is on the friendly side of the FEBA and has supplies which are below the emergency resupply threshold, a request will be placed for an airlift of the urgently needed supplies and the remainder will be ordered by ground. If emergency airlift is not required (or not possible), all supplies will be ordered by ground transport.

Once a unit has a list of supplies, required orders are placed at its servicing supply point(s) (Figure 9-7). The quantity of each supply type ordered is the minimum of:

- Amount needed
- Amount the unit can haul
- Amount available at the supply point

Once this quantity has been determined, the supplies and trucks are set aside. If the unit's primary supplier for a supply type is unable to provide all the unit needs of that supply type, the unit will look for the remainder of any additional suppliers which he may have. Once all orders have been placed, the trucks travel implicitly to the supply point (unless the unit is on the RED side, in which case the trucks used belong to the supply point). The travel time is determined by the current distance between the unit and supply point. On arrival at the supply point, the trucks request loading facilities to load the supplies. If the unit is killed before the trucks depart the supply point, the supplies are unloaded and returned to stock and the trucks are turned into the maintenance system for reissue to units which need them. Otherwise, the trucks travel implicitly to the unit. If the unit is killed while the trucks are enroute, the trucks return the supplies to the supply point and the trucks are turned into the maintenance system for reissue. If the unit is still alive, then the supplies are unloaded and the trucks become available for another resupply mission.

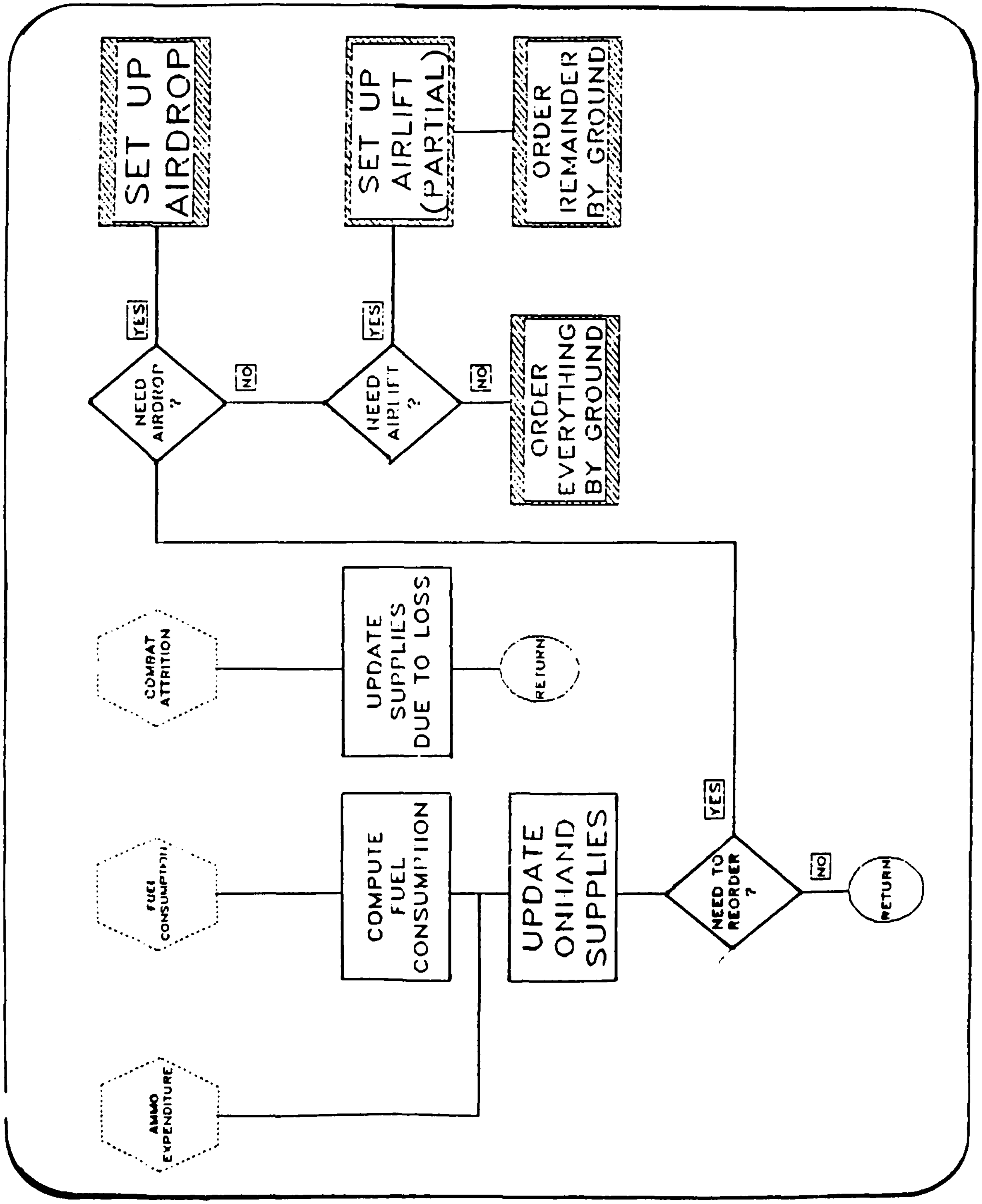



Figure 9-6. Unit Resupply System.

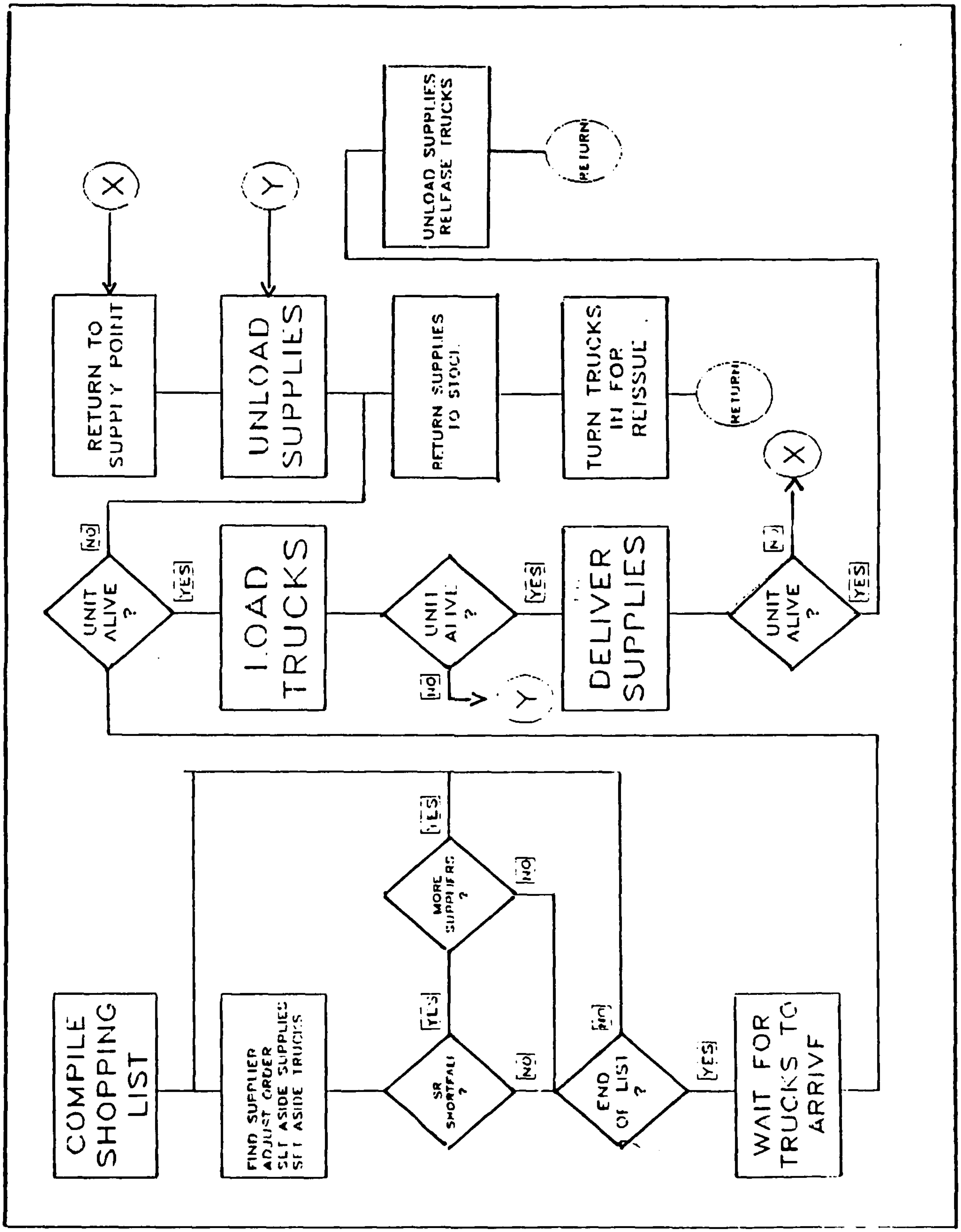



Figure 9-7. Unit Ground Resupply System.

When a unit requires an emergency airlift (Figure 9-8), it must have:

- A supplier with airlift capability
- Aircraft available at a supporting aviation unit
- A need for a minimum number of aircraft

The minimum number of aircraft which is allowed to fly a resupply mission is a user input and may have a different value for each aircraft type. If either of these three requirements are not met, then the request is cancelled and all needed supplies are ordered by ground. If they are all met, then the aircraft flies to the supply point and the supplies are loaded. If the unit is killed before the aircraft depart the supply point, then the supplies are returned to inventory and the aircraft return to their home base. Otherwise, the aircraft fly to the unit's location. If the unit dies while aircraft are enroute, the supplies are dumped and the aircraft go home. Otherwise, the supplies are dropped to the unit and the aircraft go home. The aircraft are subject to enemy interdiction and RAM failures throughout the mission. If any aircraft are lost between the supply point and the customer unit, a corresponding quantity of supplies are also lost.

Airdrops behind enemy lines (Figure 9-9) follow the same procedure as airlifters with two exceptions:

- When the unit is behind enemy lines, any supplies which cannot be delivered by air are not delivered.
- Air delivery behind enemy lines requires aircraft which have been designated as being allowed to fly into the enemy territory.

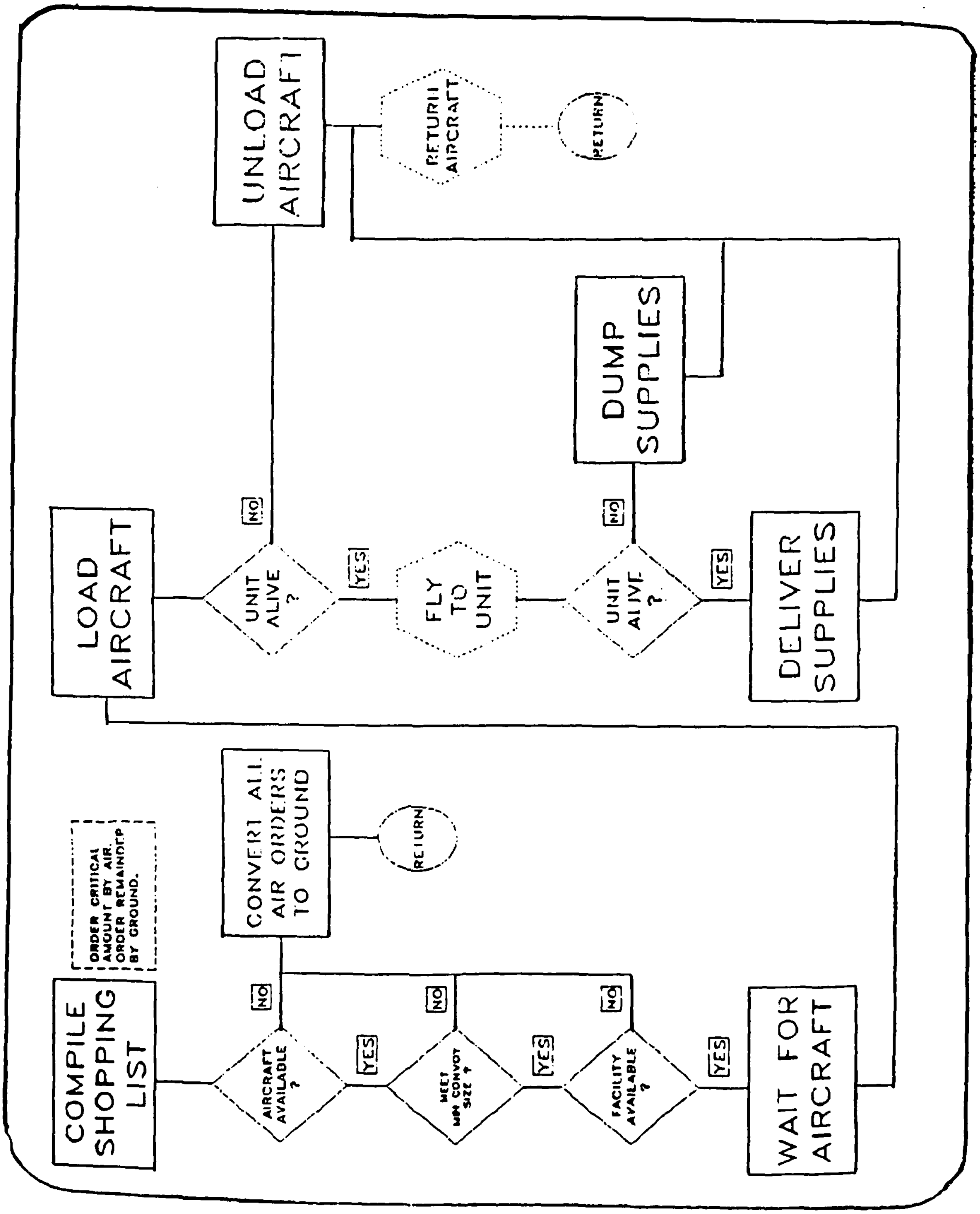



Figure 9-8. Emergency Airlift.

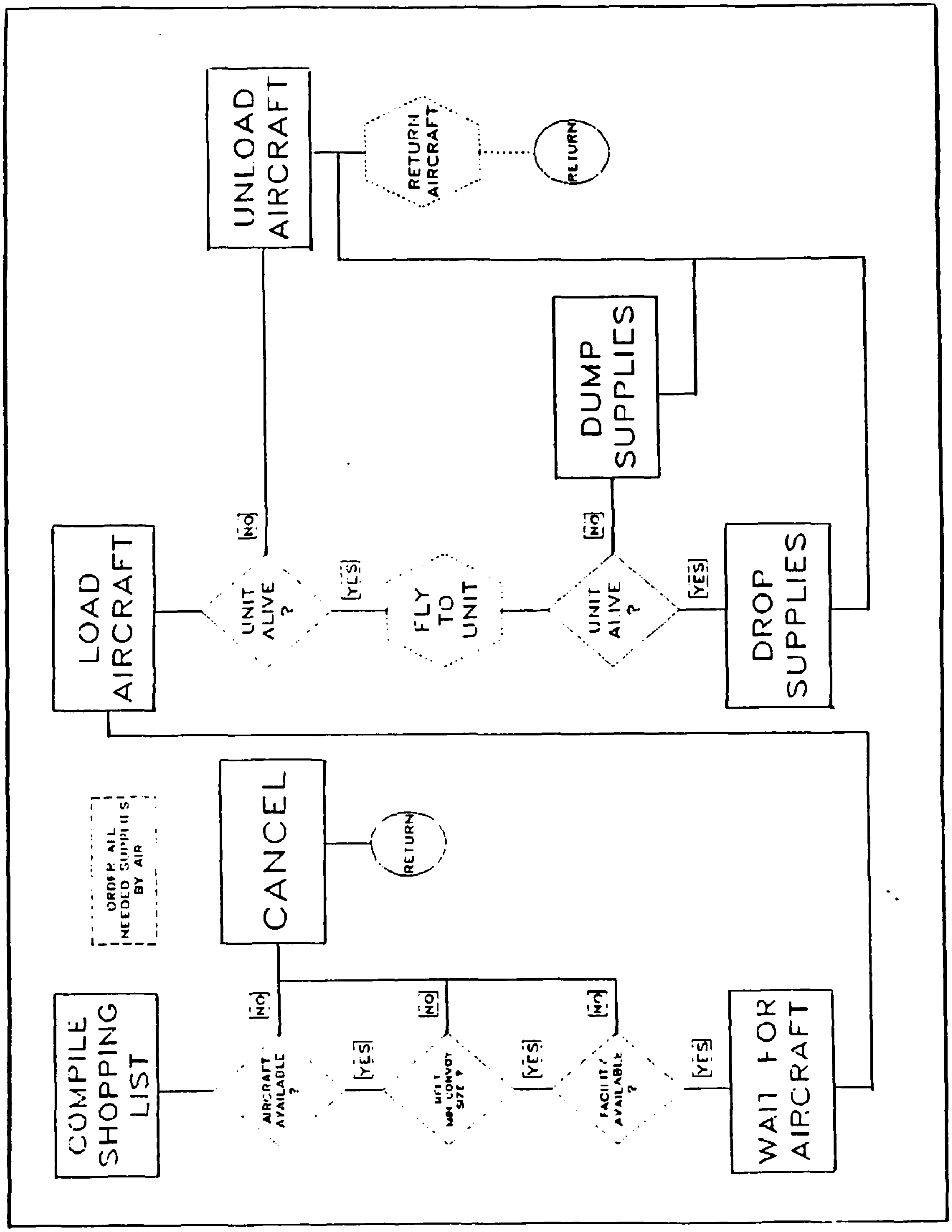



Figure 9-9. Airdrop.

If airborne insertions or other deep maneuvers are planned and it is expected that the unit(s) involved may be cutoff from the supply system, or that a large quantity of supplies may be needed by a unit, an external event allows for preplanned deliveries (Figure 9-10). The input data for this external event includes the: time of delivery, customer unit identification, supplier identification, and quantities of supplies (a percentage of the unit's total supply allowance). At the specified time, the supplies are removed from the supplier's stocks and, following an input time delay, they are added to the receiving unit's stock set. This event does not utilize any gamed transportation assets; it is based on the assumption that required aircraft will be made available due to the importance of the mission which is supported.

## PREPLANNED AIRDROP
### VIC-CSS TRANSPORTATION

- PURPOSE
  - ✓ SUPPORT AIRBORNE/DEEP MANEUVERS
- INPUT DATA REQUIRED
  - ✓ TIME, SUPPLIER, UNIT, QUANTITY
- METHODOLOGY
  - ✓ REMOVE SUPPLIES FROM SUPPLIER
  - ✓ IMPLICIT TRAVEL (TIME DELAY)
  - ✓ ADD SUPPLIES TO UNIT'S STOCKS
- ASSUMPTIONS
  - ✓ AIRCRAFT WILL BE AVAILABLE

Figure 9-10. Preplanned Airdrop.

Figure 9-11 provides an overview of line haul resupply. As Forward Supply Points (FSP) issue supplies to the maneuver units, they must periodically replenish their own stocks. Each FSP generates supply requests at one or more Rear Supply Areas (RSA). Each RSA then generates supply orders to be filled. These orders are adjusted to the availability of supplies and trucks, and to meet convoy size criteria. Once the orders are filled, they are loaded onto trucks and delivered. The trucks are then returned and made available for future convoy missions.

## VIC-CSS LINE HAUL RESUPPLY
### OVERVIEW

- CYCLIC, INTERNALLY RESCHEDULED
- MAJOR FUNCTIONS
  - GENERATE SUPPLY REQUESTS (CUSTOMER)
  - GENERATE SUPPLY ORDERS
  - ADJUST ORDERS FOR:
    - ✓ AVAILABILITY OF SUPPLIES
    - ✓ AVAILABILITY OF TRUCKS
    - ✓ CONVOY SIZE
  - FILL ORDERS
  - DELIVER SUPPLIES
  - RETURN TRUCKS

Figure 9-11. Line Haul Resupply Overview.

When generating supply requests (Figure 9-12), each FSP looks at each supply it stocks and determines how much, if any, it needs to reorder. If the quantity on hand plus the quantity already on order is below the authorized level, but above the reorder threshold, none is requested. For each supply type which requires a resupply, a request is generated.

- CHECK EACH SUPPLY TYPE STOCKED
  - TEST.AMT = AMT.AUTH * REORDER.FRAC
  - CUR.AMT = AMT.ON.HAND + AMT.ON.ORDER
  - IF CUR.AMT < TEST.AMT,
    AMT.REQ = AMT.AUTH - CUR.AMT
    ADD AMT.REQ TO AMT.ON.ORDER
    FILE REQUEST IN SET.OF.REQUESTS
- LOOP OVER REMAINING SUPPLY TYPES
- IF SET.OF.REQUESTS IS NOT EMPTY,
  GENERATE SUPPLY ORDERS

Figure 9-12. Generate Supply Requests.

After the FSP has prepared all of its supply requests, it generates supply orders (Figure 9-13) and files them at the appropriate RSA(s). Any requests which cannot be filled are destroyed.

- FOR EACH REQUEST IN SET.OF.REQUESTS,
  - FIND PRIMARY SUPPLIER
  - LET AMT.ORD = AMT.ORD * FRAC.FURN
  - LIMIT AMT.ORD TO AMT.AVAILABLE
  - SUBTRACT AMT.ORD FROM AMT.REQ
  - IF AMT.REQ > 0,
    GO TO NEXT SUPPLIER
    ORDER REMAINDER OF AMT.REQ
- LOOP OVER REMAINING REQUESTS
- DESTROY ANY UNFILLABLE REQUESTS

Figure 9-13. Generate Supply Orders.

Each RSA makes any necessary adjustments to the size of all orders before filling any of them (Figure 9-14). First, all orders are adjusted to the availability of supplies at the RSA. Any shortages are applied equally to all customers. For example, if several customers are ordering a total of 100,000 gallons of diesel fuel and the RSA only has 80,000 gallons on hand, then each customer's order for diesel fuel is reduced by 20%. Next, orders are adjusted for the availability of trucks to haul the supplies. Again, any shortages are distributed across the board. Finally, each separate convoy shipment must be checked against the size limitations

for convoys. If any convoy is smaller than the minimum allowable convoy size, all orders for that convoy are cancelled. If any convoy exceeds the maximum convoy size, each order in that shipment is received by an equal amount. For example, if the maximum convoy size is 24 and a shipment requires 32 trucks, each order in that shipment is reduced by 25%. Once all adjustments have been completed, the supplies and trucks are reserved and the orders are filled.

- ADJUST FOR SUPPLIES AT SUPPLIER:
  APPLY SHORTAGE(S) ACROSS THE BOARD
- ADJUST FOR TRUCKS AT SUPPLIER:
  APPLY SHORTAGE(S) ACROSS THE BOARD
- ADJUST FOR CONVOY SIZE:
  TREAT EACH CONVOY SEPARATELY
  - IF MIN CONVOY SIZE IS NOT MET,
    CANCEL THIS ORDER
  - IF MAX CONVOY SIZE IS EXCEEDED,
    REDUCE AMT OF EACH SUPPLY TYPE
- SET ASIDE SUPPLIES AND TRUCKS

Figure 9-14. Adjust Orders.

The procedure to fill orders is outlined in Figure 9-15. Before the supplies can be loaded, a delay is encountered while the trucks travel implicitly from the transportation company to the RSA. This travel delay is a function of the RSA and the truck type. If the trucks for a shipment are capable of self-loading (e.g., palletized loading system), no loading facilities are requested. Otherwise, the convoys queue up for loading facilities. As loading facilities become available, the trucks are loaded at a rate which is a function of the supply point and the truck type.

Once the loading is complete, the shortest route on the Main Supply Route (MSR) is computed. Current levels of traffic are considered and, therefore, the shortest route may not be the one with the fewest number of miles in it. The route having the quickest estimated travel time is the one selected. A convoy entity is then created and the convoy is activated. The convoy must travel as a "unit" in order to be able to travel explicitly and be subject to enemy interdiction enroute. Finally, the convoy is dispatched to its destination. After all orders of a particular cycle are filled, any implicit resupply is performed.

- GET LOADING FACILITY (IF NECESSARY)
- LOAD SUPPLIES ONTO TRUCKS
- GENERATE PATH (ON MSR)
- BUILD CONVOY ENTITY
  - ACTIVATE A CONVOY UNIT
  - FUEL THE TRUCKS
- DISPATCH CONVOY
- PERFORM IMPLICIT RESUPPLY

Figure 9-15. Fill Orders.

The procedure for delivering supplies is outlined in Figure 9-16. On arrival at the destination FSP, the convoy queues for unloading facilities (if necessary) and unloads the shipment. If any trucks were lost enroute due to either enemy attack or RAM failure, a corresponding portion of each supply type in the shipment is also lost. Any retrograde shipments are then implicitly loaded without using the FSPs loading facilities. This is done as a time delay which is a function of the truck type and the FSP. Fuel trucks (tankers) may have a zero delay while dry cargo vehicles may have a nonzero value. Further, some FSPs may be expected to have a large retrograde shipment requirement while others may not.

When the convoy is ready to return, the return route is constructed based on current traffic conditions and the convoy is on the road again.

- GET UNLOADING FACILITY (IF NECESSARY)
- UNLOAD SUPPLIES
- ADD SUPPLIES TO INVENTORY
- SUBTRACT AMT.REQ FROM AMT.ON.ORDER
- CONSTRUCT RETURN PATH
- SEND TRUCKS BACK

Figure 9-16. Deliver Supplies.

As outlined in Figure 9-17, if the trucks return loaded because the customer FSP had been killed, they are unloaded and the supplies are returned to the inventory of the RSA. The convoy crew then implicitly unloads any retrograde shipment and performs crew maintenance. This is a delay time similar to, but independent of, the retrograde load time. A truck type, supply point combination may well have a zero retrograde load delay, but still have a nonzero return delay to account for after-operation maintenance on the trucks. The trucks are then available for further duty. Finally, unused fuel is accounted for, the convoy unit is deactivated and the convoy entity is destroyed.

- IF TRUCKS RETURN LOADED:
  - GET UNLOADING FACILITY (IF NECESSARY)
  - UNLOAD TRUCKS
  - RETURN SUPPLIES TO INVENTORY
- UNLOAD BACKHAUL & DO CREW MAINTENANCE
- ACCOUNT FOR UNUSED FUEL
- RELEASE TRUCKS FOR FURTHER DUTY
- DEACTIVATE CONVOY UNIT
- DESTROY CONVOY ENTITY

Figure 9-17. Return Trucks.

Pipelines and hoselines may be represented in VIC-CSS in either of two forms (Figure 9-18). They may represent pipelines from outside the corps, in which case the supplier is not an explicitly gamed supply point, or they may represent pipelines or hoselines from an explicitly gamed supplier to a customer supply point. Each pipeline played has a start time and an end time, a flow rate, and a list of fuel types. If desired, you may play more than one pipeline/hoseline between the same two supply points.

The flow rate is expressed as both a quantity and a frequency. This allows, for example, 800 gallons per hour which may be a pipeline or hoseline or something like 800,000 gallons per 12 hours which may be a rail shipment. In the latter case, the railroad would be implicit and the train would travel implicitly. If an explicitly gamed railroad system is desired, the gamer may set up a railroad network as a subset of the MSR. The trains would then be "convoys" composed of a special type of "supply trucks" that happen to have steel wheels.

Once the pipeline is in operation, a delivery of the quantity specified is made at the frequency specified, but only if neither the supplier nor the customer is relocating at that time. If more than fuel type is assigned to the pipeline, the ratio of quantities delivered is set equal to the ratio of quantities needed at the customer supply point, subject to that amount being available at the supplier.

Currently, pipelines are not subject to either enemy attack or RAM failure. A future enhancement to the model is envisioned to allow both of these actions.

- SOURCE TYPES
  - ✓ IMPLICIT - EAC
  - ✓ EXPLICIT
- CHARACTERISTICS
  - ✓ START TIME & END TIME
  - ✓ FLOW RATE & LIST OF FUELS
- METHODOLOGY
  - ✓ QUANTITY DELIVERED
  - ✓ RATIO OF FUEL TYPES

Figure 9-18. Pipelines.

## 9.3 VIC-CSS OUTPUT.

As shown in Figure 9-19, the model provides several formatted reports concerning the performance of the supply and maintenance/medical systems. These include supply point relocation summaries and unit supply status reports, as well as supply-transportation reports.

The supply-transportation reports include detailed reports on each convoy as well as transportation statistics for each supply point. The convoy reports tell, for each convoy, the origin and destination supply points, supply category, queueing time at origin and destination, loading time at origin and destination, and time spent on the road. In addition, the quantities of each supply type delivered by that convoy is reported.

The transportation statistical summaries give, on a cyclic interval, the numbers of trucks queueing, loading, traveling, and lost enroute. The length of the report cycle is an input data item.

The maintenance/medical system reports include information on all recoveries, repairs, evacuations, and reissues of each weapon type by each maintenance/medical unit during the simulation and a summary of all maintenance/medical unit relocations. The performance report also includes statistics on the numbers of weapons and personnel in the various queues. Like the supply reports, the maintenance report cycle length is input data.

In addition to the formatted reports, extensive CSS history files are available. A record of the occurrence of virtually every action in the supply and maintenance/medical activities is written to either the supply or the maintenance/medical history file. Analysis of VIC-CSS output, with respect to those parameters which represent the transportation system, will result in an indication of how the transportation system performed during the simulated battle. The analyst may examine both the effects of combat on the transportation system and the effects of the transportation system on the outcome of the battle.

## LOGISTICS/SUPPLY

- RELOCATION
  - NUMBER OF MOVES
  - TIME OF 1st MOVE
  - AVG. TIME BETWEEN MOVES
  - UNIT DOWN TIME DUE TO MOVES
  - AVG. RELOCATION DISTANCE
- SUPPLY STATUS BY UNIT AND BY SUPPLY TYPE
  - SUPPLY TYPE
  - AUTHORIZED
  - ON HAND
  - AMOUNT ISSUED/USED BY CYCLE AND CUM
  - AMOUNT LOST BY CYCLE AND CUM
  - AMOUNT RECEIVED BY CYCLE AND CUM
  - AMOUNT SHORT BY CYCLE AND CUM

## TRANSPORTATION/CONVOYS BY TRUCKLOADS AND BY SUPPLY TYPE

- FROM WHICH UNIT
- TO WHICH UNIT
- TYPE OF CONVOY
- QUEUE TIME AT ORIGIN AND DESTINATION
- LOAD TIME AT ORIGIN AND DESTINATION
- TRAVEL TIME

Figure 9-19. Reports.

## TRANSPORTATION/SUPPLY POINT

- NUMBER OF TRUCKS QUEUED AT ORIGIN AND DESTINATION
- NUMBER OF TRUCKS LOADING AT ORIGIN AND DESTINATION
- NUMBER OF TRUCKS ON THE ROAD
- NUMBER OF TRUCKS IN USE
- NUMBER OF TRUCKS LOST

## RETURN TO DUTY BY WEAPON TYPE AND MAINT UNIT

(REPORTED BY CYCLE AND CUM)

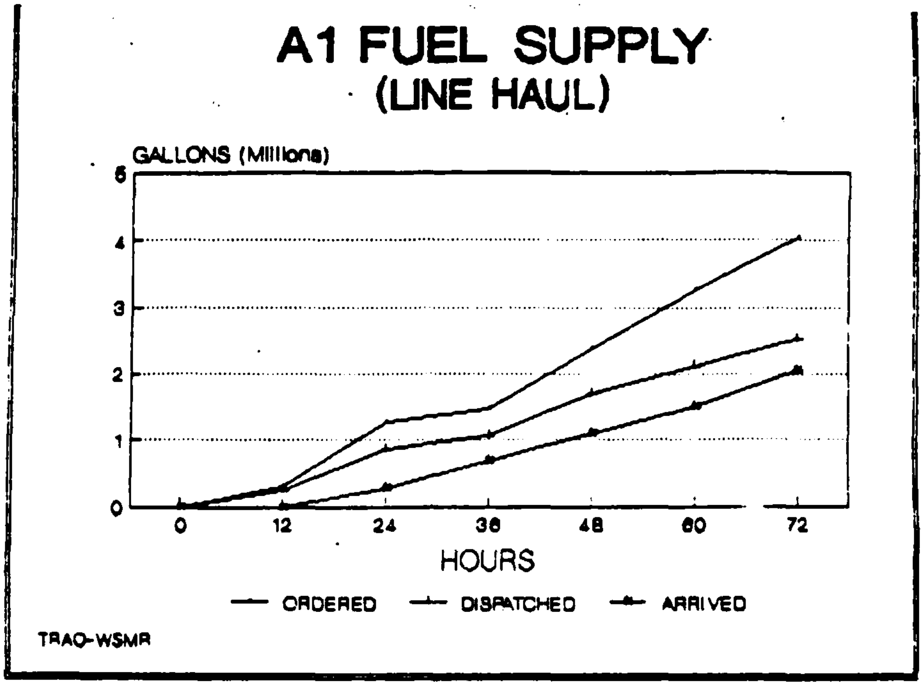
- NUMBER OF COMBAT DAMAGED
- NUMBER RAM FAILURES
- NUMBER VEHICLES ABANDONED
- NUMBER OF K-KILLS
- NUMBER OF COMBAT DAMAGED RECOVERED
- NUMBER OF RAM FAILURES RECOVERED
- NUMBER OF REPAIRS COMPLETED
- NUMBER OF REISSUES
- NUMBER AWAITING REISSUE
- NUMBER AWAITING REPAIR
- NUMBER AWAITING EVACUATION
- NUMBER AWAITING RECOVERY

## RETURN TO DUTY/RELOCATION

- NUMBER OF MOVES
- TIME OF 1st MOVE
- AVG TIME BETWEEN MOVES
- UNIT DOWNTIME DUE TO MOVES
- AVG RELOCATION DISTANCE

Figure 9-19. Reports (Continued).

For example, as shown in Figure 9-20, the convoy report from a particular simulation may indicate an inability to deliver fuel as rapidly as desired. The statistical summary of the supply points' transportation assets may yield insight into the cause of this problem: Do we need more tanker trucks or a more efficient pumping system? If a more detailed analysis of the transportation system is required, the VIC-CSS output can be used as input to higher resolution, function-specific models.



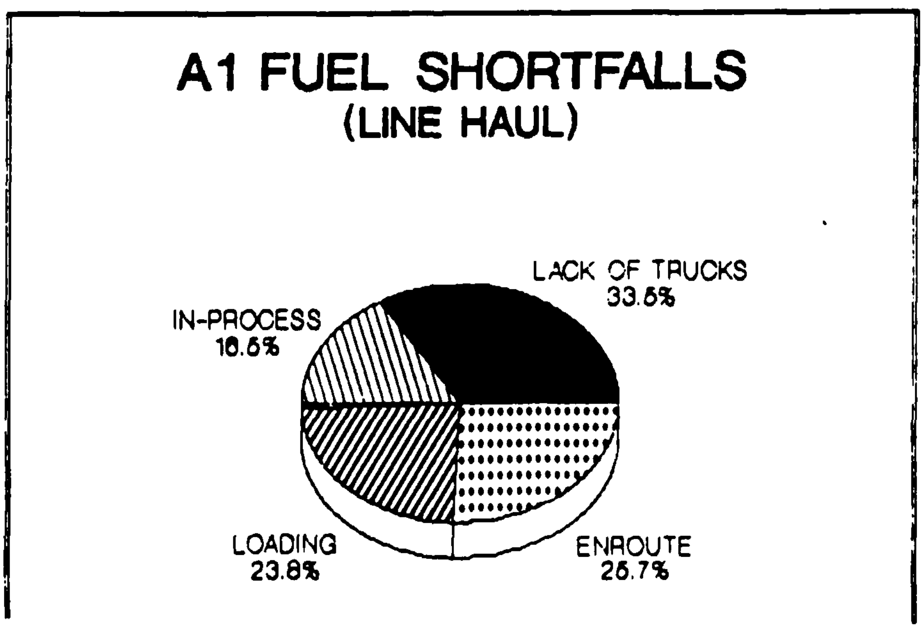




Figure 9-20. Example Results.

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# CHAPTER 10

## DEVELOPMENT OF ATTMA DATABASE

by Vladimir "Lud" Vukmir

and Steve Wourms

ABSTRACT: For the past several years, the USAF Aeronautical Systems Division (ASD) has sponsored, as one of its long term planning projects, an activity to support Headquarters, Military Airlift Command (MAC) in developing data to support the preparation of a Statement of Operational Need for its next generation tactical airlifter. This activity is known as the Advanced Transport Technology Mission Analysis (ATTMA) and is a joint effort being worked by the Deputy for Development Planning (ASD/XR) and the Flight Dynamics Laboratory (AFWAL/FI) at ASD, and MAC/XP.

### 10.0 PRESENTATION OUTLINE.

I - Overview of ATTMA Program

II - Effectiveness Analysis Model

III - Scenarios

IV - Airlift Jobs

V - Deficiency Analysis

### 10.1 OVERVIEW OF ATTMA PROGRAM.

The adoption of AirLand Battle doctrine and the development of concepts describing its evolution into the 21st Century imply an increasing reliance on airlift to support the Army and Air Force near and beyond the Forward Line of Own Troops (FLOT). This need, together with an ever increasingly sophisticated threat to intratheater airlift worldwide, produce important implications about the future requirements for USAF intratheater airlift.

Our concern at ASD is in insuring that technology thrusts are sufficient to support 21st Century USAF system developments for intratheater airlift. We are also concerned with identifying and quantifying the key system-level tradeoffs for such a development program.

With these perceived changes in the nature of warfare and with our concern for technological readiness to meet future airlift development requirements, a mission analysis of the transport technology area was undertaken in early 1986.

As shown in Figure 10-1, the objective of the Advanced Transport Technology Mission Analysis (ATTMA) was to establish the analytical basis and the rationale to support Headquarters, Military Airlift Command in the development of a Statement of Operational Need (SON), which is the first major step in the life of a new program, and to support the appropriate technology development for the next generation USAF tactical airlifter.

Products of this extensive analysis include: a comprehensive database highlighting system needs, technology opportunities, and potential solution concepts; an evaluation of those solution concepts which were developed; and a technology development plan capable of allowing the timely development of the identified concepts.

The ATTMA was a joint effort by the Deputy for Development Planning (ASD/XR) and the Flight Dynamics Laboratory (AFWAL/FI), both at Wright-Patterson Air Force Base, and Headquarters, Military Airlift Command (MAC/XP) at Scott Air Force Base. ASD/XR was responsible for systems analysis, AFWAL/FI for technology, and MAC/XP for airlift operations.

## ADVANCED TRANSPORT TECHNOLOGY MISSION ANALYSIS

**OBJECTIVE:** ESTABLISH ANALYTICAL BASIS AND RATIONALE TO SUPPORT STATEMENT OF OPERATIONAL NEED (SON) AND TECHNOLOGY DEVELOPMENT FOR NEXT GENERATION TACTICAL AIRLIFTER

**PRODUCTS:**

- COMPREHENSIVE DATA BASE HIGHLIGHTING SYSTEM NEEDS, TECHNOLOGY OPPORTUNITIES, AND POTENTIAL SOLUTION CONCEPTS
- EVALUATION OF SOLUTION CONCEPTS
- TECHNOLOGY DEVELOPMENT PLAN

**JOINT PROGRAM:** AFWAL, MAC, ASD/XR

Figure 10-1. Advanced Transport Technology Mission Analysis.

As shown in Figure 10-2, the approach to the ATTMA began with an extensive needs analysis that evaluated the baseline force of intratheater airlift performing representative jobs in likely environments containing projected threat and defined infrastructure. The result was a deficiency analysis of the baseline force. This presentation will focus on our approach to the needs analysis.

Based on an evaluation of technology opportunities and the identified needs for an intratheater airlifter, many system concepts were developed as potential solutions. These candidate concepts were then evaluated in the same manner as the baseline force in the earlier needs analysis to determine their capability to satisfy identified needs and costs.

- NEEDS ANALYSIS
  - THREAT
  - INTRATHEATER JOBS
  - BASELINE FORCE
  - DEFICIENCY ANALYSIS
- TECHNOLOGY OPPORTUNITIES
- SYSTEM CONCEPTS
- EVALUATION

Figure 10-2. ATTMA Approach.

The first ATTMA iteration was during the pre-concept exploration phase with the objective of quantifying deficiencies in the baseline airlift force. Three primary scenario regions were used for this analysis as shown in Figure 10-3. They will be described in more detail later in this presentation.

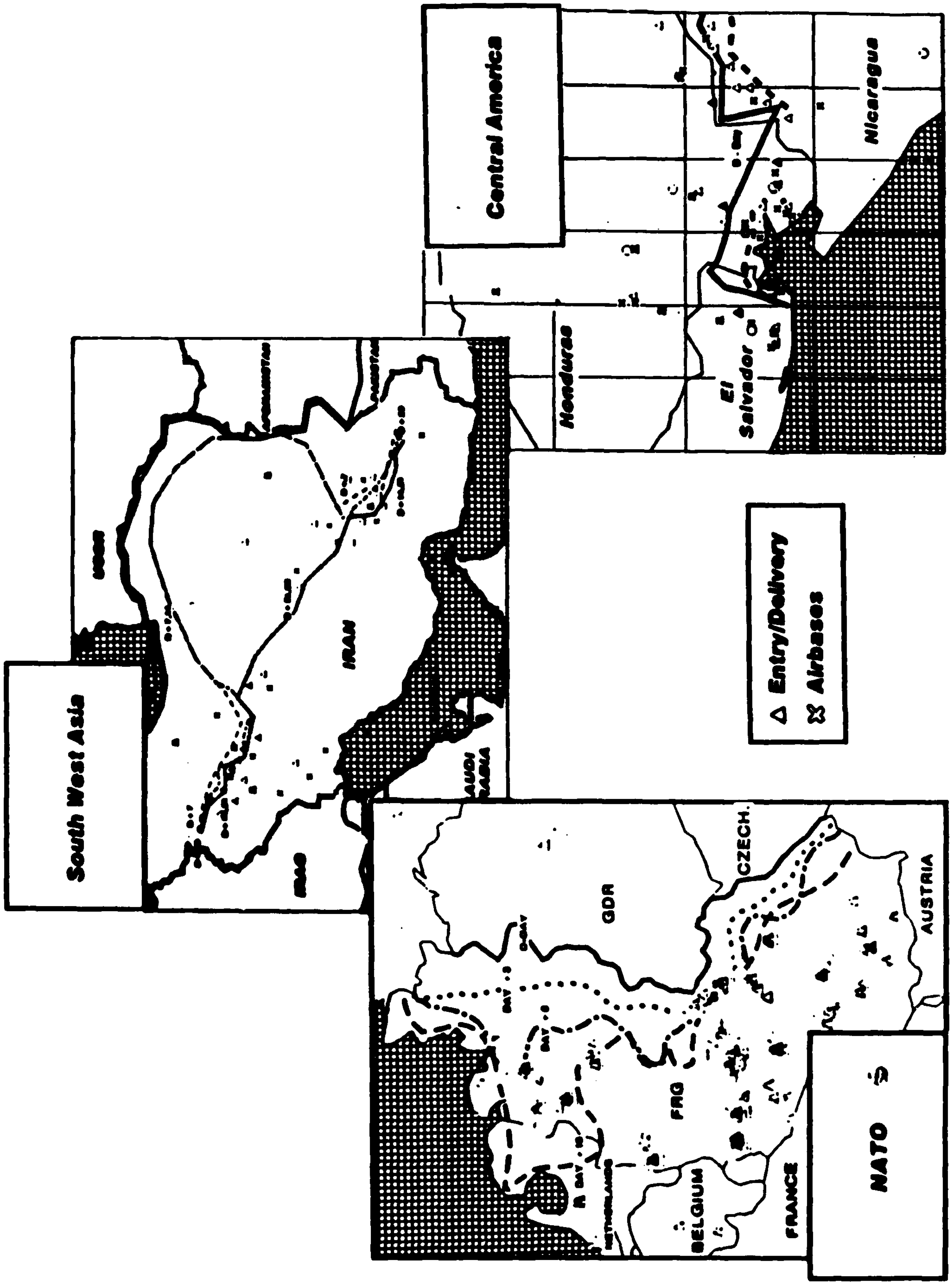



Figure 10-3. Scenario Regions.

The scenario regions selected were each representative of a different threat intensity (Figure 10-4). Central America, as a low-threat environment, had a threat characterized by small arms and automatic weapons, optically guided AAA guns, and hand held infrared (IR) surface-to-air missiles (SAMs). The medium-threat environment of South West Asia (SWA) was characterized by small arms and automatic weapons, radar guided AAA guns (with an optical backup), IR SAMs (both hand held and crew served), and radar guided SAMs. However, these were not the latest technology systems in most cases and they were not effectively linked to each other and to control systems to optimize the entire air defense system. NATO was representative of a high-threat environment. The threat types were basically the same as found in SWA, but they represented the latest technology and were effectively linked into a total air defense system.

| | THREAT TYPE | THREAT INTENSITY |
|---|---|---|
| NATO | SMALL ARMS AND AUTOMATIC WEAPONS<br>RADAR 23/30MM AAA<br>IR SAMS<br>RADAR SAMS | 1.0 |
| SOUTHWEST ASIA | SMALL ARMS AND AUTOMATIC WEAPONS<br>RADAR 23/30MM AAA<br>IR SAMS<br>RADAR SAMS | 0.7 |
| CENTRAL AMERICA | SMALL ARMS AND AUTOMATIC WEAPONS<br>OPTICAL 23MM AAA<br>HAND HELD IR SAM | 0.25 |

Figure 10-4. Threat Characterization.

Airlift jobs were defined for each of the three theaters within the primary mission categories of deployment, employment, retrograde, alternate missions, and reconstitution. Each job description included details such as specific cargo, tonnage, dimensions, frequency, initial location, destination, and proximity to threat.

The significant drivers of each scenario are shown in Figure 10-5. The NATO scenario is characterized by a high-threat environment, a good infrastructure of roads, railroads, and logistical support, relatively short ranges to destinations from the origin airfields, and the availability of many suitable airfields. The SWA theater has a poor infrastructure, much longer flight ranges than NATO, and the availability of few suitable airfields. Finally, the Central American scenario has an equally poor infrastructure, but with short flight ranges and many small, primitive airfields.

- **NATO**
  - THREAT
  - GOOD INFRASTRUCTURE
  - SHORT FLIGHT RANGES
  - MANY AIRFIELDS
- **SWA**
  - POOR INFRASTRUCTURE
  - LONG FLIGHT RANGES
  - FEW AIRFIELDS
- **CA**
  - POOR INFRASTRUCTURE
  - SHORT FLIGHT RANGES
  - MANY SMALL AIRFIELDS

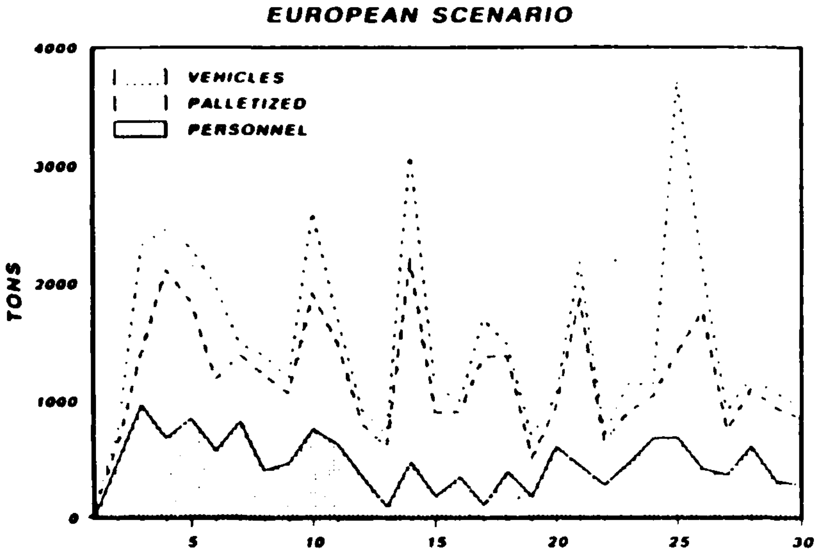
Figure 10-5. Scenario Drivers.

Figure 10-6 summarizes representative intratheater airlift demand functions contained in the three scenario job definitions. While the total tonnage demands are similar for both the NATO and SWA scenarios, the NATO demand is heavier in passengers and ammo, while the SWA is heavier in vehicles and bulk cargo. The Central American scenario, with much less total demand, has a heavy percentage of the total demand in fuel. That latter scenario also shows the highest demand for near and across FLOT delivery (38%), but that is misleading since the threat environment is so low in that theater.

The purpose of the concept development iteration was to develop a matrix of airlift vehicles for subsequent mission and system analysis, and to identify benefits, penalties, and development issues associated with those concepts.

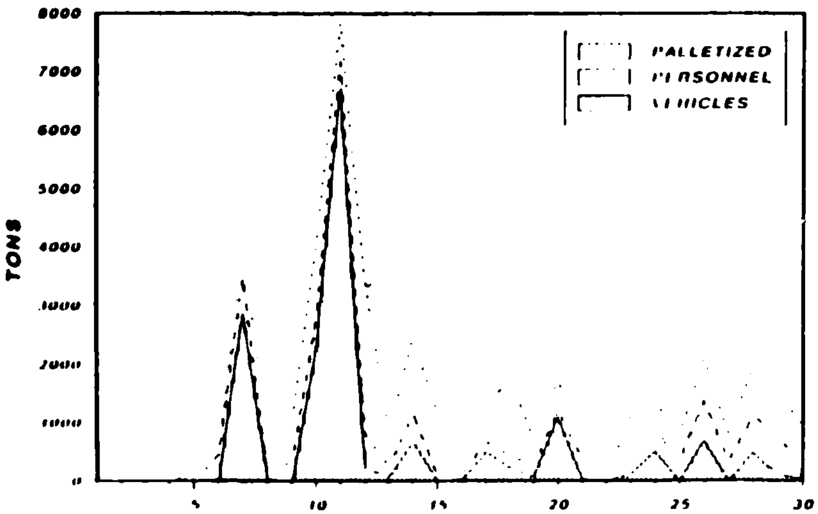
General Research Corporation (GRC) was contracted to develop the mission scenarios and job definitions. Boeing Military Aircraft, Douglas Aircraft, and Lockheed Aircraft-Marietta were each awarded contracts to analyze needs and develop system concepts over a spectrum of possible solutions. That matrix of solutions included short takeoff and landing (STOL), very short takeoff and landing (VSTOL), and low observable systems including large, medium, and small cargo compartments (relative to the current C-130 aircraft).

In-house efforts at ASD focused on development of effectiveness evaluation tools, survivability analysis, technology assessment, and cost analysis.




## TONNAGE REQUIRED
## (30 DAYS)

| | NATO | SOUTHWEST ASIA | CENTRAL AMERICA |
|---|---|---|---|
| TONS | 47482 | 47500 | 9700 |
| PAX % | 30 | 19 | 19 |
| BULK<br>FUEL %<br>AMMO | 15<br>11 (47)<br>21 | 28<br>6 (44)<br>10 | 13<br>26 (56)<br>17 |
| VEHICLES % | 23 | 37 | 25 |
| ACROSS FLOT % | 10 | 13 | 16 |
| NEAR FLOT % | 12 | 5 | 22 |



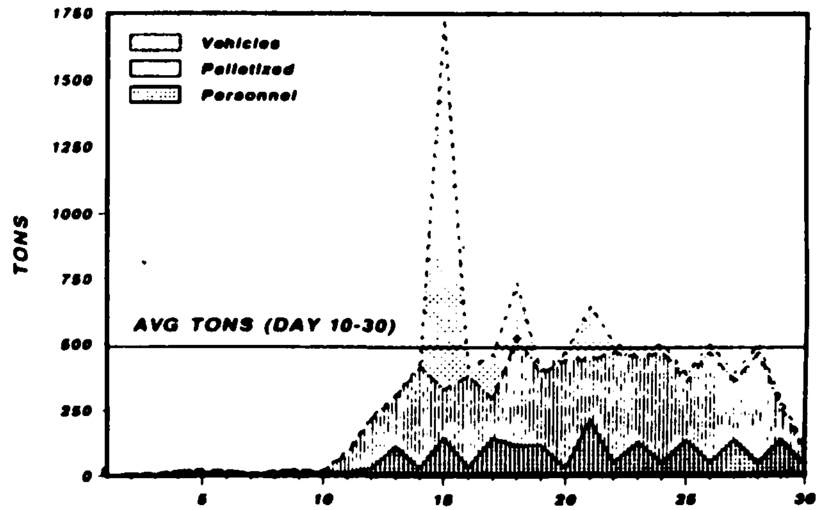




Figure 10-6. Demand Function.

Common themes emerging from contractor and USAF in-house efforts in this first phase are outlined in Figure 10-7.

- The propfan externally blown flap (EBF) concepts provide the least cost solution as long as threat losses were not a consideration.

- There is a high payoff in airlift effectiveness for concepts with a short field capability (less than 2000 feet long).

- Low radar, infrared, and visual signatures as well as effective countermeasures and external support are very important to the survival of an aircraft in the high-threat environment.

- There is a very severe threat to aircraft on the ground in the terminal area when those sites are near to or beyond the FLOT.

- The baseline C-130 fleet of airlifters is not able to meet all future theater airlift requirements.

- An airlifter must fly at low altitude (approximately 200 feet) when it is within range of threat acquisition devices in order to survive.

- The size of the cargo box for a future airlifter is driven by the need to carry the 155mm towed howitzer.

- There is some potential commonality between the smallest cargo box concepts of the future airlifter and the requirements for an aircraft to support special operation forces (SOF).

- PROPFAN EBF - LEAST COST CONCEPT
- HIGH PAYOFF FOR SHORTFIELD CAPABILITY
- NEED LOW SIGNATURES, COUNTERMEASURES, SUPPORT TO SURVIVE IN HIGH THREAT ENVIRONMENT
- TERMINAL AREA GROUND THREAT - VERY SEVERE
- C-130 FLEET DEFICIENT FOR FUTURE THEATER AIRLIFT
- LOW ALTITUDE FLIGHT IS A "MUST"
- BOX SIZE DRIVEN BY 155mm TOWED HOWITZER
- SMALL CONCEPTS - ALL SAME SIZE WITH SOF-COMMONALITY

Figure 10-7. Common Themes.

## 10.2 EFFECTIVENESS ANALYSIS MODEL.

One of the major activities of the ATTMA was the development of a tool to evaluate effectiveness of alternative airlifter concepts. The Generalized Air Mobility Model (GAMM) described in Figure 10-8 was the primary product of this effort. It is a user friendly, interactive simulation of intratheater airlifter operations with associated logistics support and aircraft attrition.

- **PROVIDES CAPABILITY TO PERFORM INTRATHEATER AIRLIFT SYSTEM ANALYSIS**
- **INCLUDES: GROUND OPERATIONS, SURVIVABILITY/VULNERABILITY, ROAD MARCH, AND AIRDROPS**
- **INPUTS: MOVEMENT REQUESTS, AIRFIELD CHARACTERISTICS, AND AIRLIFTER CHARACTERISTICS**
- **OUTPUTS: CHRONOLOGICAL AIRLIFTER AND JOB ITEM LISTINGS**

Figure 10-8. GAMM Description.

GAMM was developed under contract by the General Research Corporation (GRC) in close coordination with ASD/XRM. It is written in SIMSCRIPT II.5 and has interactive graphics. It operates on a MicroVAX (or better) system with 6 MB of random access memory and at least 60 MB of removable disk storage capability. Development continues today as an ASD/XRM activity.

GAMM is a stochastic simulation which requires that a run be replicated and averaged in order to obtain realistic results. Such a "production environment" requires that GAMM be implemented in a purely batch mode. A pre-processor is used to prepare inputs, and outputs are condensed and organized with a post-processor.

Many Measures of Merit can be calculated by GAMM. As shown in Figure 10-9, some of those measures are the daily and cumulative tonnage delivered over the scenario period, the daily and cumulative tonnage delivered within the required user time parameters, the deliveries by job priority, the number of sorties flown, the utilization rate of the aircraft, and the number of aircraft attrited by the threat.

Tons on time is considered to be one of the most important measures to theater airlift because it provides insights into the responsiveness of an airlifter.

- TONS DELIVERED (TD)
- TONS ON TIME (TOT)
- TD/TOT BY JOB PRIORITY
- SORTIES
- UTE RATE
- AIRCRAFT ATTRITED

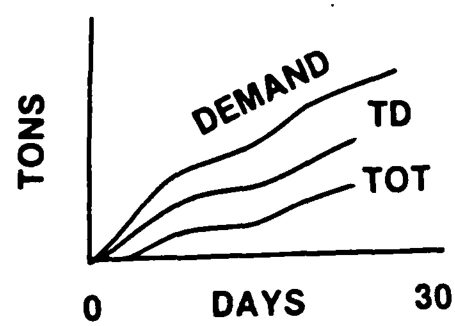



Figure 10-9. GAMM Measures of Merit.

GAMM uses 48 characteristics of an airlifter (see Figure 10-10) as inputs. These characteristics include the required takeoff and landing distance of the aircraft at many different combinations of useful load, temperature, and altitude, and the runway hardness requirements (e.g., LCN) as a function of the useful load of the aircraft.

- TO AND LAND DISTANCE AT 28 COMBINATIONS OF USEFUL LOAD, TEMP, AND ALTITUDE
- LCN REQUIREMENT AS FUNCTION OF USEFUL LOAD
- CRUISE SPEED, FUEL CAPACITY AND CONSUMPTION
- CARGO BOX CAPACITIES
- MISSION ESSENTIAL AND NON-ME FHBF
- SURVIVABILITY AND VULNERABILITY
- LOAD/UNLOAD, SERVICE, AND MAINTENANCE TIMES
- NUMBER OF AIRCRAFT, ALONG WITH HOME BASING ASSIGNMENTS

Figure 10-10. GAMM Airlifter Characteristics.

As illustrated in Figure 10-11, an entry/delivery (E/D) site is linked to any number of airfields, as determined by the analyst. These links consist of the time to travel by ground between the E/D site and each airfield, and the probability of survival of the ground transport vehicles. Figure 10-11 also lists information which must be provided for each airfield. LCN (load classification number) is a measure of the runway's ability to withstand repeated landings, MOG (Maximum aircraft On Ground) and SPOTS specify the number of aircraft permitted at the field, runway attack and repair information randomly cuts and then repairs the runway, and the *probabilities of survival* ($P_s$) are both airlifter specific.

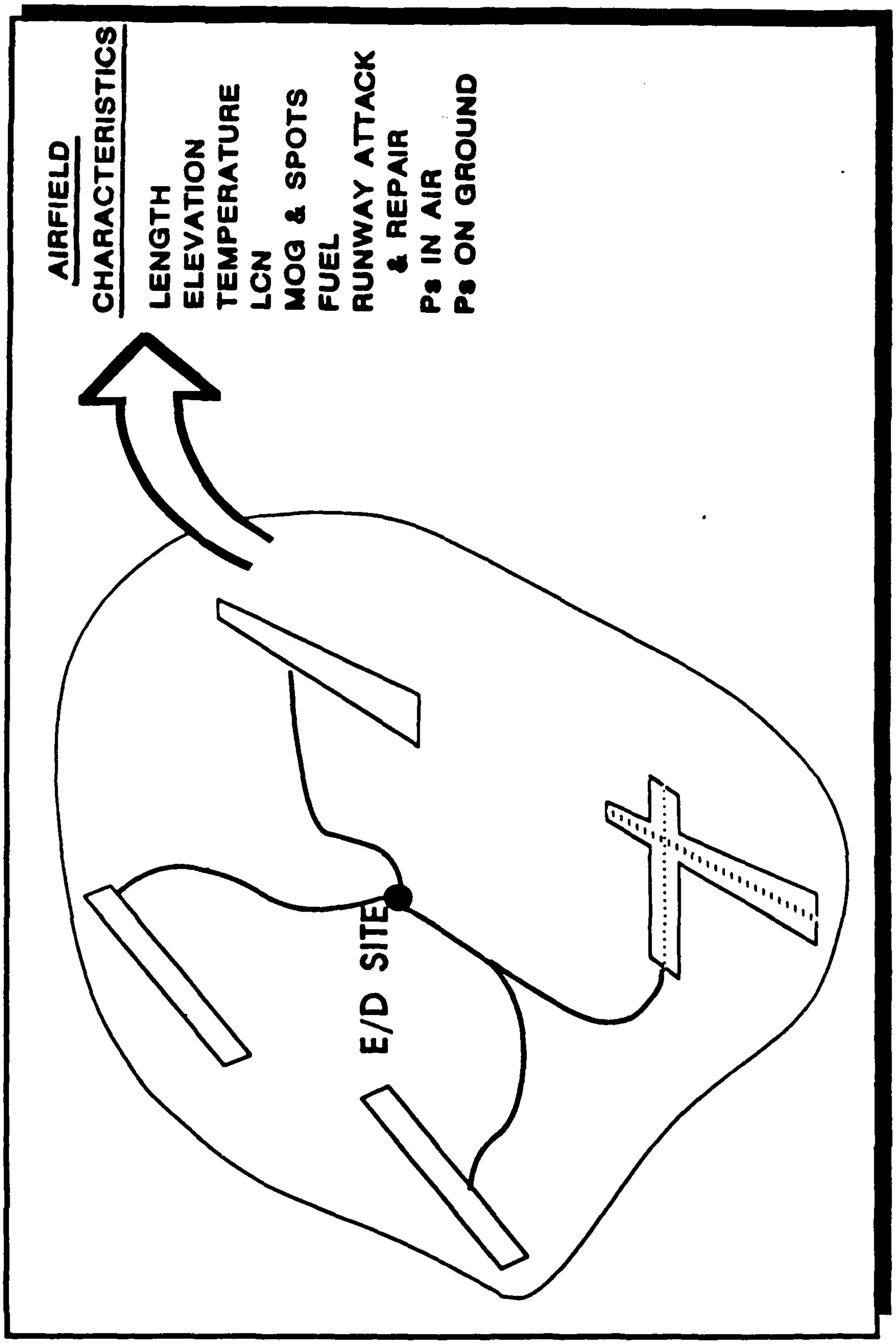



Figure 10-11. Entry/Delivery Site Runway Network.

Figure 10-12 illustrates the movement of a job within GAMM. The cargo (job) is first moved by ground transport from the entry site to an associated airbase. A probability of survival P(S) is associated with the movement of jobs between entry sites and airbases. GAMM then checks each airbase supporting the cargo destination site for runway length, fuel availability, MOG limitations, runway LCN, and fuel required to fly to the destination airbase. If an airbase can be found that will support the airlifter flight, cargo loading begins; if not, the GAMM's scheduler will select a different set of cargo to be moved and repeat the process.

If the takeoff or destination airbases were attacked during loading operations and the resulting usable runway is no longer sufficient, the flight will be canceled. The aircraft itself is subject to damage during normal ground turnaround. If battle damage is sustained, the flight will be canceled and the airlifter will return to its home airbase for repair.

If a feasible flight for the airlifter is found, it will takeoff with its cargo for the previously selected airbase supporting the cargo's delivery site. There is a P(S) for the flight similar to that for the entry site to airbase leg. While enroute, the destination airbase could be attacked so that the useful runway length is no longer sufficient to accommodate the inbound aircraft. When this occurs, GAMM first attempts to divert to any other airbase supporting the delivery site, then to the airlifter's home base, and then to any other airbase.

The first function performed upon landing at the destination airbase is cargo unloading. Next, the airlifter is serviced and maintenance is performed. Maintenance actions are determined next by sampling a Poisson distribution of Mission Essential (ME) and non-ME failures. Now the airlifter is again ready for scheduling. The jobs unloaded from the airlifter will make their way to the delivery site based on the P(S) associated with the ground transportation network.

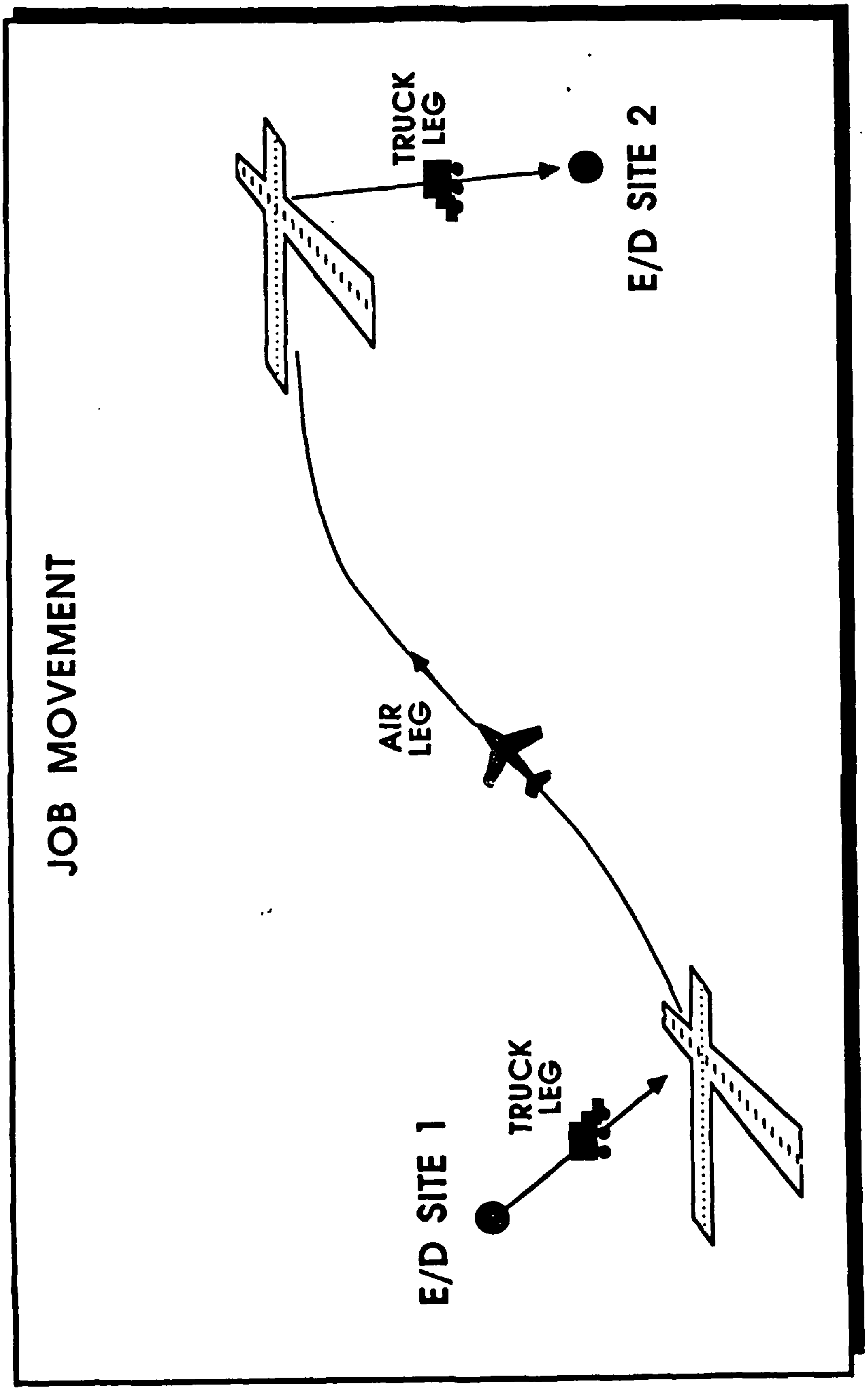



Figure 10-12. GAMM Job Movement.

GAMM "rules" are summarized in Figure 10-13. Jobs are scheduled by job priority. The type of airlifter to be used follows another priority scheme (e.g., tactical airlift aircraft are used before available strategic airlift). The nearest capable base or landing site to the in-theater cargo origin (E/D site) is selected and aircraft at that location are used if possible. Otherwise aircraft are relocated to pick up the cargo.

Probabilities of survival are input for road march and airborne legs of the jobs and at landing sites for ground operations. Additionally, battle damage is assessed. Job items are regenerated whenever they are lost due to attrition.

Loading and unloading operations follow log-normal distributions. The user may choose to load by weight and volume or by weight only, and can specify that highest priority items be moved first.

If any assigned job is not completed within a given maximum time limit, the remainder of the job is deleted. These situations result in a reduction of the total tonnage delivered, since the undelivered job items are not sitting in queues at airbases, waiting for a "slow day." However, job items are moved in a much more timely manner this way, and silly situations such as making an emergency resupply delivery three weeks late are obviated.

Inputs to GAMM provide for degradation caused by enemy attack of airbase runways and delays caused by needed repairs. Similar inputs account for the dangers from operating in areas subject to threat interception or degradation, both on the ground and in the air.

Airdrop missions are used into forward combat areas not supported by airbases or too dangerous for airlifter ground turnaround. In addition to ingress and egress P(S) values, a P(S) value is input for the airdropped cargo items.

Finally, each airlift aircraft has an in-theater home base to which the aircraft returns at the end of the crew day and when it has no further

- JOB SCHEDULING
  - BY JOB PRIORITY
  - BY AIRCRAFT PRIORITY
  - NEAREST CAPABLE BASE TO E/D SITE
  - AIRCRAFT RELOCATION
- SURVIVABILITY
  - AIRBORNE/GROUND
  - BATTLE DAMAGE
  - JOB REGENERATION
- LOADING/UNLOADING
  - BY PRIORITY/WIDEST FIRST
  - TIME
- JOB DELETIONS
- AIRBASE ATTACK & REPAIR
- OPERATIONS IN THREAT
- AIRDROP MISSIONS
- HOME BASING
  - END OF CREW DAY
  - RETURN IF NO WORK
  - NON-ME MAINTENANCE
  - ABD REPAIR

Figure 10-13. GAMM "Rules".

missions waiting to be flown. Here all non-mission essential maintenance is performed as well as all battle damage repair. Mission essential maintenance will also be performed as required.

Finally, Figure 10-14 shows a schematic of the inputs and outputs of the GAMM model. Movement requests are generated from the jobs file with a mission, cargo description, urgency, frequency, and deadline provided. System concepts including airlifter operational concepts, force size and mix, and airlifter beddown locations. Also provided are cargo origin and destination, available airfield characteristics, survivability factors, airlifter characteristics, and other environmental factors. The scheduler organizes and controls airlift operations while the transportation model calculates the individual airlifter actions to include times and aircraft used. From these model calculations, measures of merit available to evaluate aircraft effectiveness include the number of tons delivered, the amount delivered on time, and the number of aircraft lost.

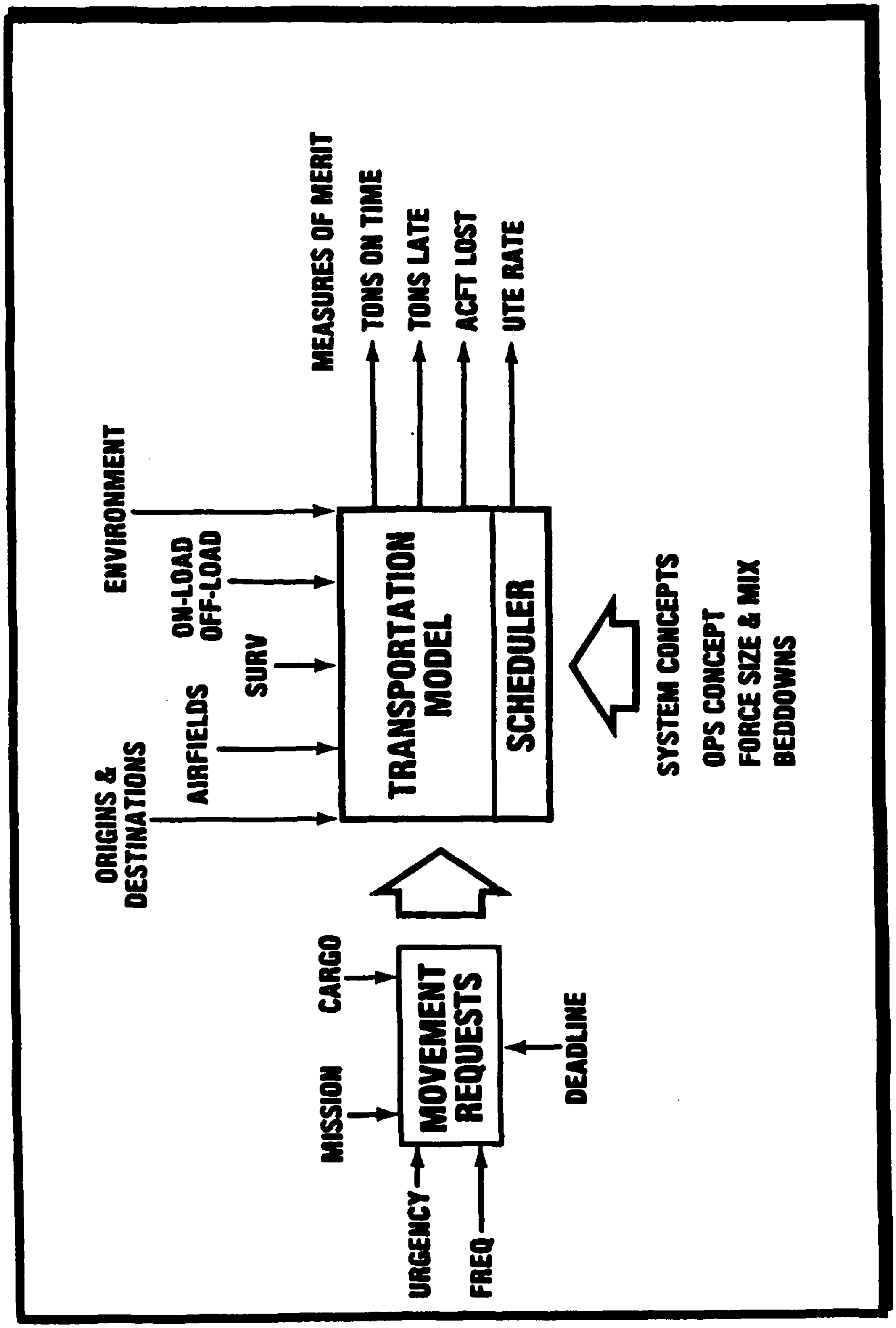



Figure 10-14. Effectiveness Analysis Model.

## 10.3 SCENARIOS.

To evaluate future airlift requirements, a baseline technical approach is required. In past analysis of tactical airlift, tons per day or ton-miles per day have been the key measures of merit. However, they do not adequately measure the value of making the airlift system less dependent on major airports and more responsive by moving cargo closer to the user. Similarly, airlifter survivability can affect productivity.

One approach to better measure tactical airlift performance is to measure the effect of the course and development of the war on the tactical airlift system. In order to apply this approach, a postulated scenario is required to determine opportunities and requirements for tactical airlift which can be refined as tactical airlift jobs.

Three different wartime scenarios were developed (NATO, SWA, and Central America) in order to examine airlift operations over a range of job demands, threat levels, and operating environments. A minimum war length of 30-days was postulated to ensure an adequate examination of wartime airlift operations, since prepositioned stocks and other in-theater supplies may suffice for a short conflict and not fully stress an airlift force and to reveal the full range of airlift requirements.

Each of the scenarios was based upon extensive research and historical analysis with extrapolation or evolution based upon current events. Each is a nonnuclear conflict occurring between the years 1995 and 2010. There was a great deal of interface with the users of airlift and with MAC to insure doctrinal integrity. ASD/XRM had these scenarios developed due to the requirement for unclassified scenarios.

Figure 10-15 shows the highlights of the European NATO Central Region scenario. A Soviet invasion was initiated after a prolonged period of increasing tensions. The Rhine River in the Federal Republic of Germany (FRG) develops as an effective barrier to the attacking forces in the Central Region. By D+30, a stalemate has been reached in the Central Region. The baseline tactical airlift forces, numbers of available airfields and VSTOL sites, and altitude and temperature conditions are shown in the enclosed box.

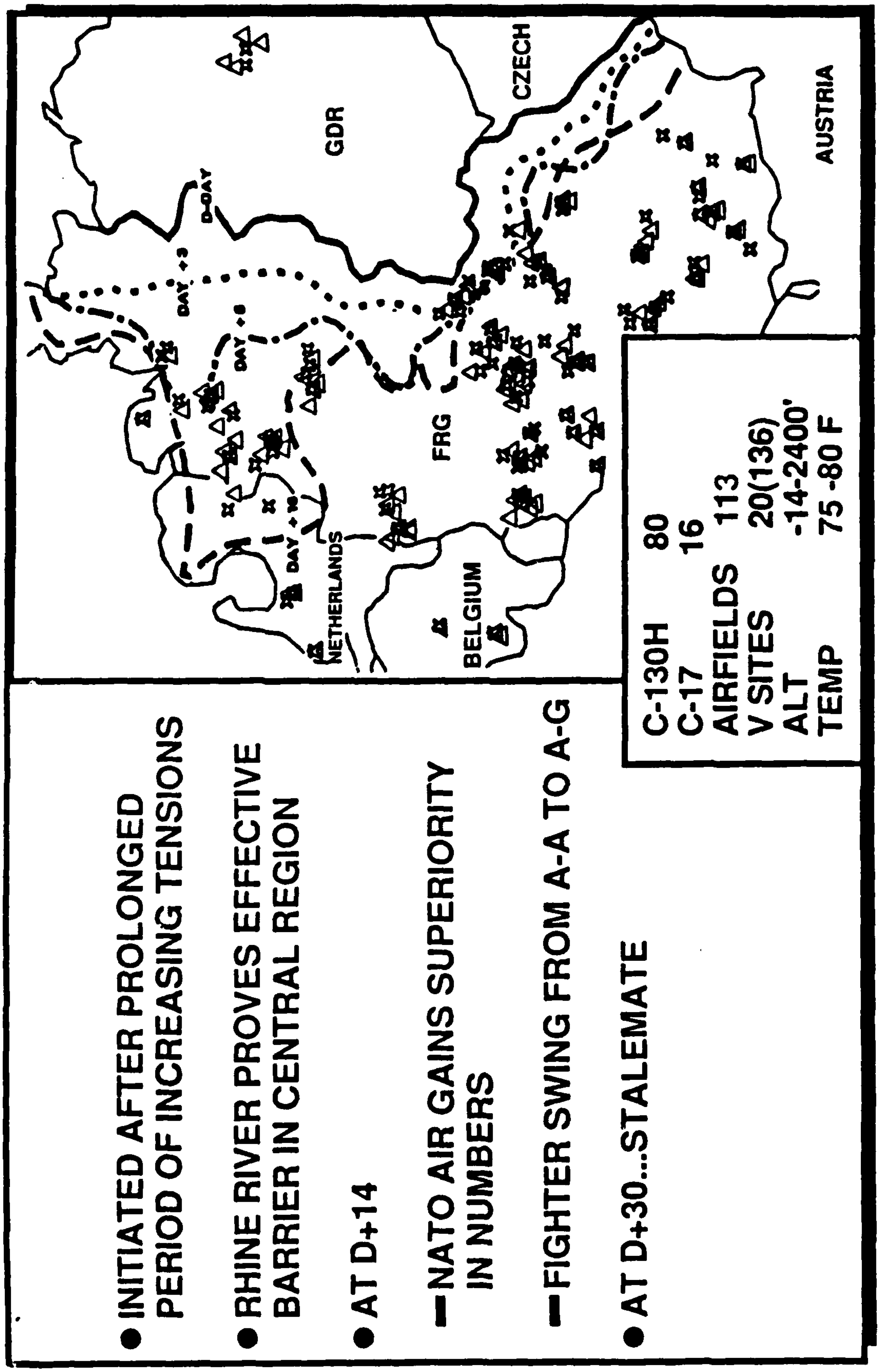



Figure 10-15. NATO Central Region 30-Day Scenario.

Figure 10-16 shows similar highlights for the Southwest Asia scenario. Soviet forces attack Iran in two prongs - the Caspian Sea and Afghanistan. The Iranians abandon Tehran and ask for U.S. assistance in repelling the attack. The U.S. agrees to assist the Iranians and sets up theater headquarters in Oman. Airlift deploys with the lead elements of the U.S. task force on D+2 and U.S. forces begin engaging Soviet forces on D+7. The fight for air superiority lasts until D+11 at which time U.S. fighter forces shift to focus on air-to-ground operations. When a stalemate is reached in southeast Iran, one U.S. division is airlifted to the northwest front (D+26) to reinforce operations in that region. Again, baseline airlift forces, available airlift operating sites, and temperature and altitude conditions are shown in the enclosed box.

Finally, Figure 10-17 provides highlights of the Central American scenario. Nicaraguan insurgents seize port cities on the Gulf of Fonseca in Honduras (D Day) which allows a surface line of communications (LOC) from Nicaragua to support insurgent operations in El Salvador and Honduras. CINC USSOUTHCOM deploys an AirLand Force (ALF) Joint Task Force (JTF) to Honduras to repel this invasion. U.S. forces have total air superiority and no surface-to-air missiles (SAMs) are encountered. The baseline airlift forces, airlift operating sites, and temperature and altitude conditions are shown in the enclosed box.

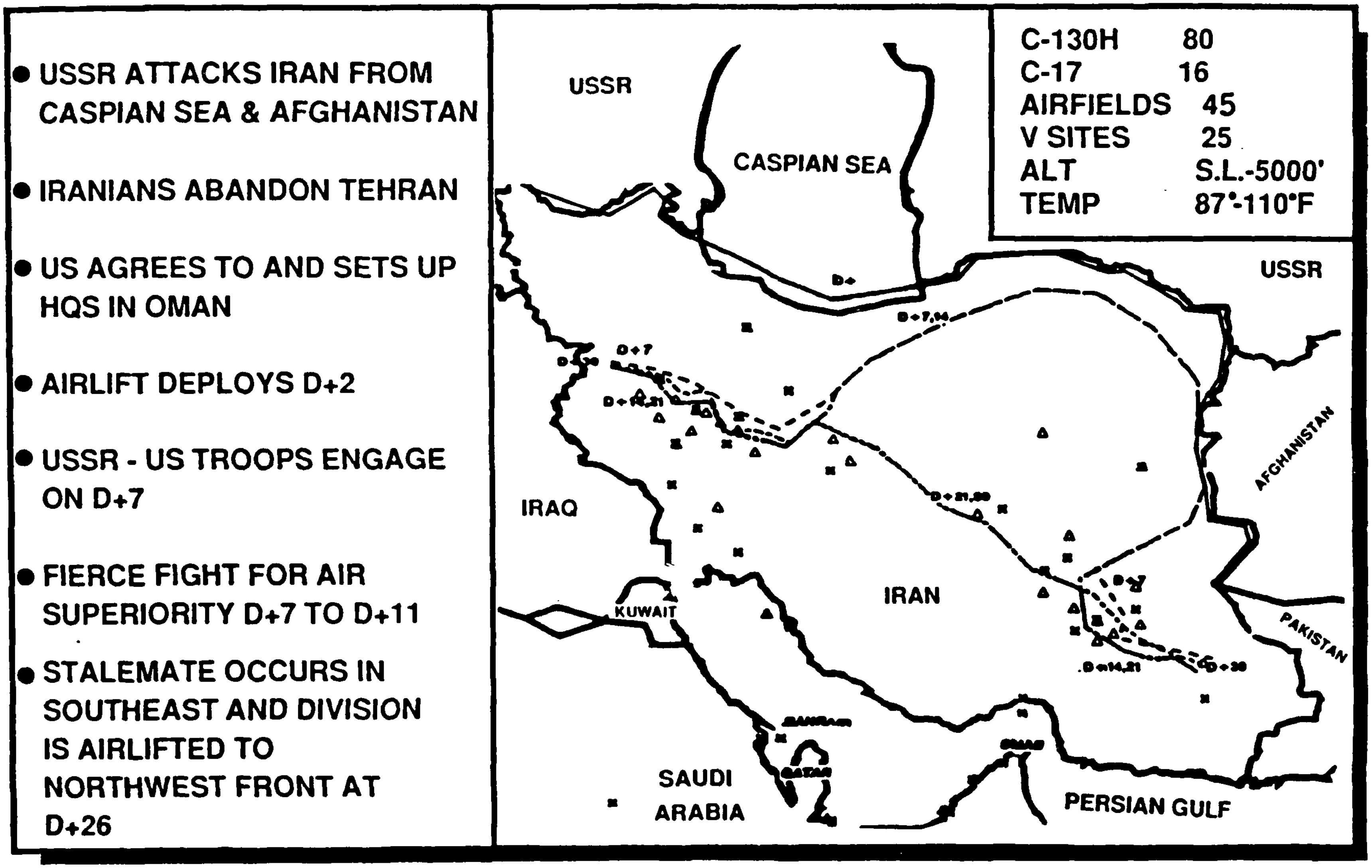



Figure 10-16. Southwest Asia 30-Day Scenario.

- INSURGENTS SEIZE GULF OF FONSECA PORT CITIES
- ALLOWS LOC FROM NICARAGUA FOR EL SALVADOR/HONDURAS INSURGENT OPERATIONS
- US CINC SOUTH DEPLOYS ALF/JTF TO HONDURAS
- US FORCES HAVE AIR SUPERIORITY AND NO SAMS ARE ENCOUNTERED

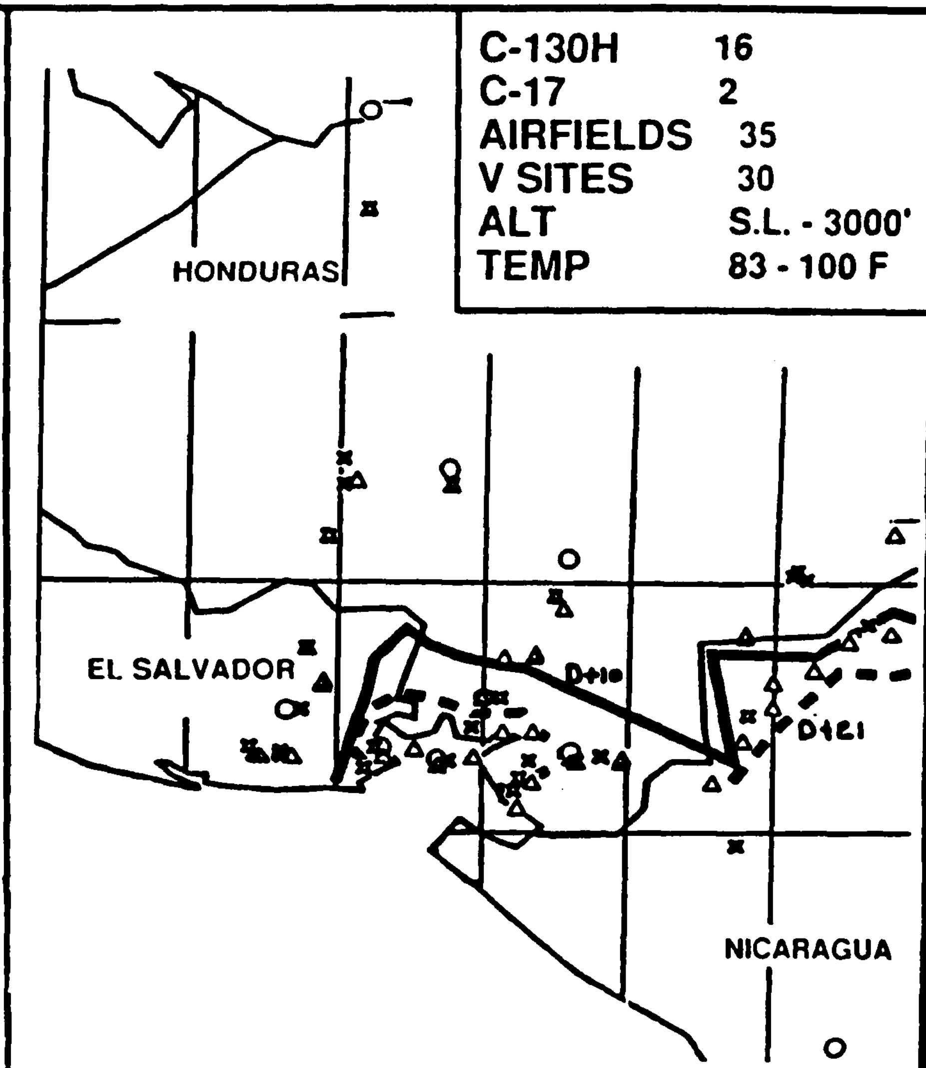



Figure 10-17. Central America 30-Day Scenario.

## 10.4 AIRLIFT JOBS.

The definition and description of jobs, or individual missions, which airlift aircraft perform is critical to measuring the effectiveness of those aircraft. They must be representative of all possible jobs and reflect reasonably well the distribution of wartime requirements for tactical airlift.

Figure 10-18 lists the major categories of airlift jobs. Deployment jobs focus on the movement of men and materiel from intermediate staging facilities to depots farther forward on the battlefield. Associated with this is the repositioning of rear elements from one position to another in order to enhance survivability or improve operational effectiveness. Force elements require airlift in order to deploy to contingency positions. The pattern of movement in this category, then, is primarily rear-to-front, with occasional lateral and rear-to-rear sorties.

Employment support jobs were also functional, but followed deployment chronologically. This category retains the rear-to-front orientation, but adds a variety of potential traffic flow patterns. It consists of jobs that support the in-place forces in their engagement of the enemy, and includes all jobs aimed at sustainment and administration of the forces, as well as support of attack on the enemy.

Concurrent with employment support, and often functioning with it to allow maximum utilization of airlift assets, is retrograde support. This category includes all tasking aimed at removing incapacitated men and inoperable equipment from forward areas for reasons other than tactical repositioning and is characterized by a virtually pure front-to-rear flow. Most retrograde support tasks are performed as backlift sorties using aircraft engaged in employment support missions.

Theater reconstitution involves all of the tasks in the first three categories, but is distinguished from them by the purpose of the mission. Reconstitution aims at regenerating a theater to normalcy after a conflict has ended.

- DEPLOYMENT
  - INTRATHEATER EXTENSION
  - SEALIFT/UNIT MARRIAGE
  - PREPOSITIONING MOVEMENT
- THEATER RECONSTITUTION
  - FORCES
  - CIVILIAN SECTOR
- ALTERNATE MISSIONS
  - $ABC^3$ FIREFIGHTING
  - ELECTRONIC WARFARE
- EMPLOYMENT SUPPORT
  - ATTACK SUPPORT
  - RESUPPLY/SUSTAINMENT
  - SCHEDULED SERVICE
  - SOF SUPPORT
- RETROGRADE SUPPORT
  - EVACUATION
  - REDEPLOYMENT
  - EXTRACTION

Figure 10-18. Categories of Jobs.

Finally, there is a range of other missions performed by tactical airlifters which are not obviously airlift related. These jobs include airborne command, control, and communications (ABC3), firefighting, and electronic warfare jobs.

Adequate descriptions of each job are included in order to answer the what, where, when, and under what conditions each job is performed. Jobs are defined irrespective of airlift resources available to accomplish the job. Furthermore, the method of delivery (e.g., airdrop, airland, low altitude parachute extraction) is not included as an integral part of the job definition. Each job is measured in its tonnage and dimensions, and described as palletized, passengers, or rolling stock. The entry and delivery sites for the cargo are included along with the distance between them. The urgency and related priority of the job is included as well as the frequency of the job during the 30-day scenario. Finally, the conditions such as terrain, weather, threat, basing, and airdrop requirements are included in each job description.

As illustrated in Figure 10-19, some jobs require the airlifter to operate near to or across the FLOT. With dependence upon the aircraft's capabilities, many different landing areas may be identified, particularly areas which are small and remote from obvious threat interdiction. These landing areas may include roadways, open fields, and small, unimproved landing strips.

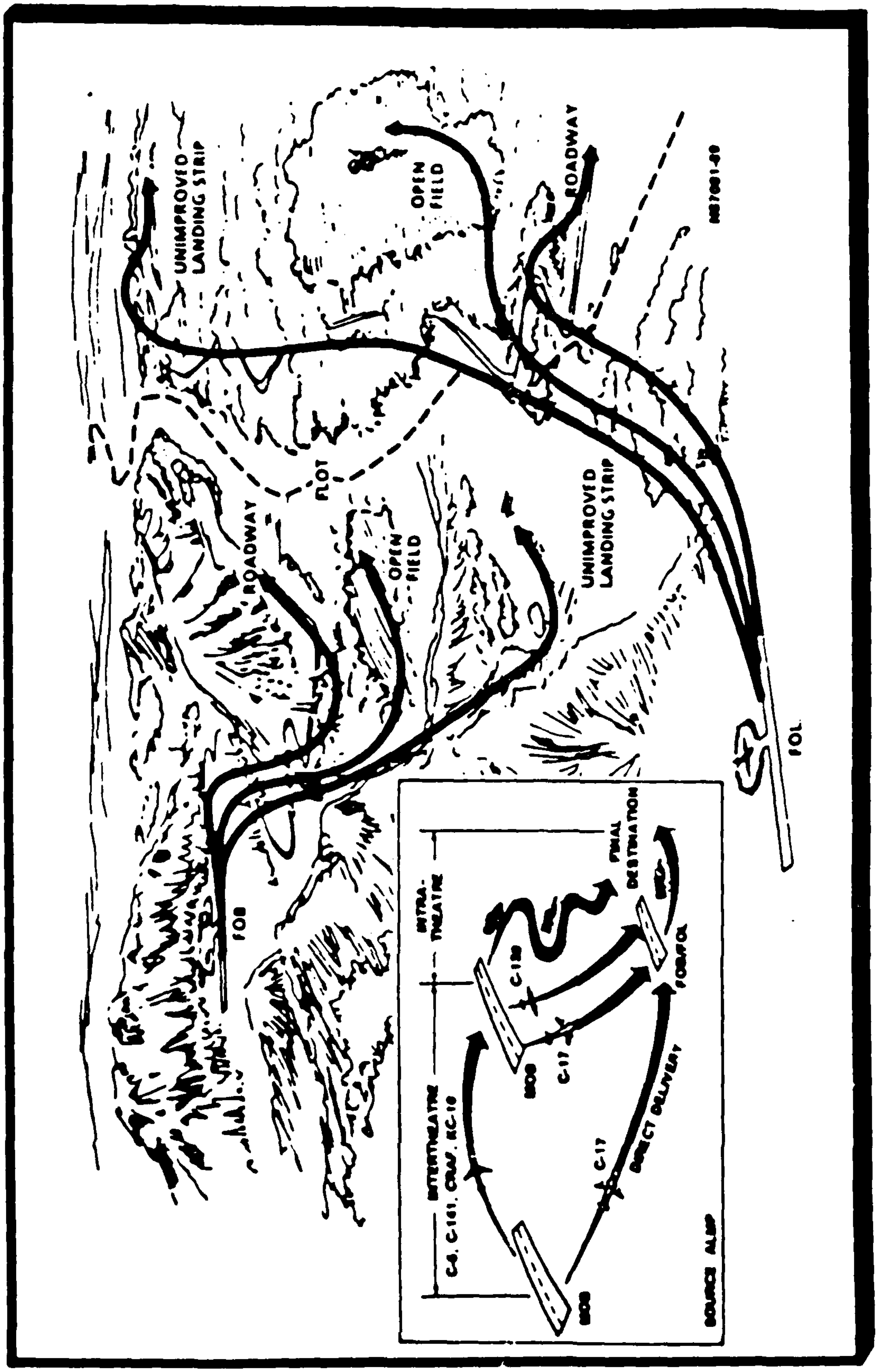



Figure 10-19. Near and Cross-FLOT Airlift Operations.

Each job is given a priority according to the scale shown in Figure 10-20. The highest priorities require very responsive closure of the needed load because of a threatened loss of a combat unit, friendly controlled territory, or non-combat unit. Lesser priorities required cargo closure in decreasingly demanding timeframes with no losses of units or territory threatened within the closure timeframe.

| PRIORITY | CLOSURE TIME | THREATENING SITUATION |
|---|---|---|
| 1-3 | ASAP | LOSS OF COMBAT UNIT/TERRITORY |
| 4 | ASAP | LOSS OF NON COMBAT UNIT/PERSON |
| 5 | 12 HRS | NO LOSS WITHIN CLOSURE TIME |
| 6 | 24 HRS | |
| 7 | 48 HRS | |
| 8 | 72 HRS | |
| 9 | NA | |

Figure 10-20. Job Priorities.

Figure 10-21 summarizes the European total job set for the first 30 days of combat. Note that the average tonnage for each job was 95. There were 137 entry and delivery sites for the cargo with 113 airfields available for airlifter use. Airlifters operated from eight different beddown airfields in the baseline scenario.

- 497 TOTAL JOBS (13% ACROSS OR NEAR FLOT)
- DEMAND IS 47,482 TONS
  - 30% PAX
  - 47% PALLETS
  - 23% VEHICLES
- 29 PRIORITIZED JOB TYPES
  - 4 - 72 HRS CLOSURE
  - 95 AVERAGE TONS PER JOB
- 137 ENTRY/DELIVERY SITES
- 113 AIRFIELDS
- 8 BEDDOWN AIRFIELDS

Figure 10-21. Europe - Total Job Set.

Figure 10-22 shows the required delivery of tonnage as a function of the day of the scenario. The European scenario is characterized by considerable variation in activity. The first week of the war shows a quick buildup and then a few days of steady demand for airlift. The remainder of the war has periods of intense activity associated with Soviet breakthroughs and encirclements and finally at day 25 an Allied counterattack. This same period also shows lulls in airlift demand. The peaks represent high demands for airlift and will stress the surge capability of the airlifters. The peaks are not so large though that they should overwhelm the airlift force structure, unless losses are high due to attrition.

Figure 10-23 takes the data of Figure 10-22 and accumulates it by day of the scenario. Palletized cargo (bulk, fuel, and ammo) accounts for one-half of all tonnage moved during the scenario. This figure also shows approximately 20% of the cargo is rolling stock (oversize and large categories). The largest single category, PAX (passenger and troops), accounts for one fourth of all tonnage moved. The "large" material category, consisting of cargo that will not fit in a C-130 or is too heavy for the aircraft, accounts for one to two percent of the total tonnage and is the smallest category. Such cargo is rolling stock which requires delivery by a larger airlifter such as the C-17.

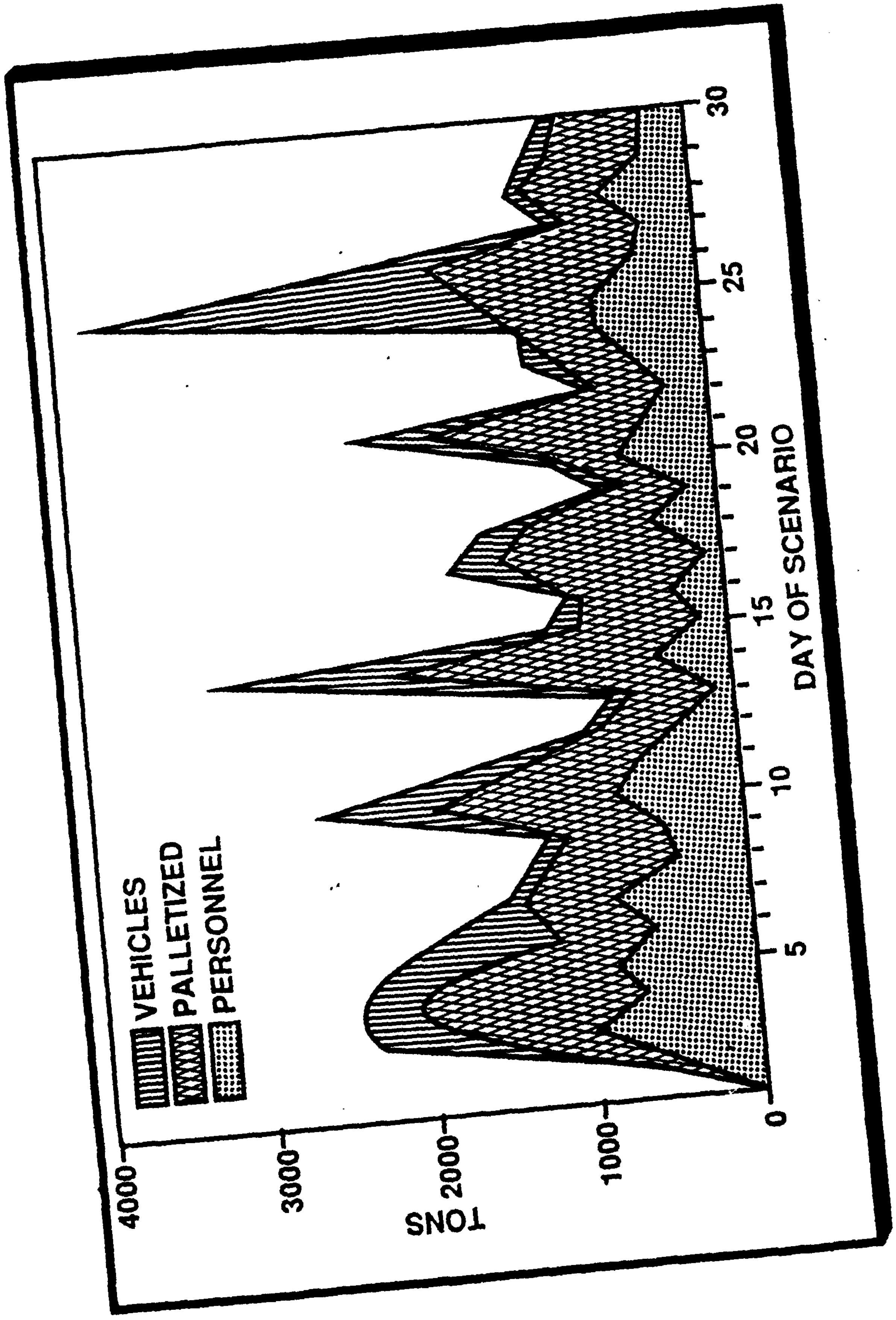



Figure 10-22. Europe Tonnage Required by Day.

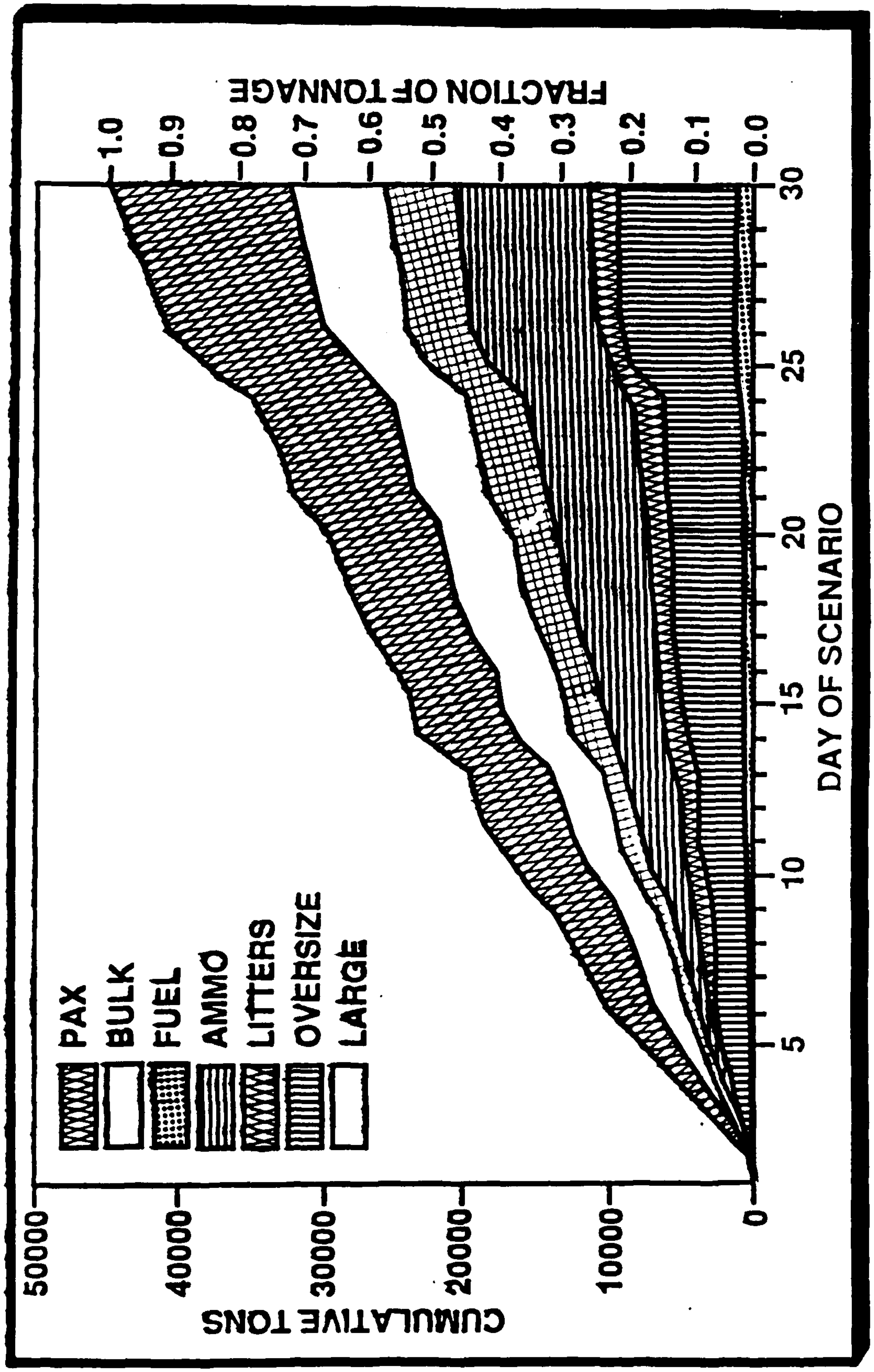



Figure 10-23. Europe Cumulative Required Tonnage.

Figure 10-24 summarizes the Southwest Asia (SWA) total job set for the first 30 days of combat. Note that the average tonnage for each job was 157, about 65% greater than the European job set average. Total tonnage demand is almost the same as for Europe, but with only about 60% as many total jobs. A much higher percentage of the cargo in SWA is vehicles with much less of the total in passengers. This scenario has only 62 entry and delivery sites, less than half of those in the European scenario, but it also has only about 40% of the total airfields available to airlifters.

- **302 TOTAL JOBS**
- **DEMAND IS 47,500 TONS**
  - **19% PAX**
  - **44% PALLETS**
  - **37% VEHICLES**
- **26 PRIORITIZED JOB TYPES**
  - **6 - 72 HRS CLOSURE**
  - **157 AVERAGE TONS PER JOB**
- **62 ENTRY/DELIVERY SITES**
- **45 AIRFIELDS**
- **5 BEDDOWN AIRFIELDS**

Figure 10-24. Southwest Asia - Total Job Set.

Figure 10-25 shows required tonnage as a function of the day of the scenario. The figure shows the total tonnage of PAX, pallets, and rolling stock delivered per day with the total per day represented by the corresponding peak. The highest activity clearly takes place on days 7, 10, 11, and 12. The tonnage to be moved during these four days averages about 5000 tons per day; during the other 26 days of the conflict, the average daily movement is only 1100 tons.

The high level of activity during the peak periods mentioned above is mainly the result of the required deployment of Land Battle Forces (LBFs) needed to counter the two main fronts of Soviet aggression, while the peak of rolling stock at day 11 is driven by the retrieval of an isolated Iranian mechanized brigade. This time period includes the deployment of two LBFs to the western Zagros Mountains, as well as another LBF and a Close Combat Force (CCF) to the Bam Valley. These forces also require weapons and ammunition. In this period, there is also a requirement for the deployment of five TACAIR wings forward to Oman and Bahrain, and three wings in-country. The two peaks near the end of the scenario (days 26 and 28) correspond to final Soviet attempts to break through to the sea.

The requirements represented by the peaks are very sortie-intensive periods of operation which place a high priority on productive gains. Potentially there could be a high payoff due to enhanced reliability/ maintainability as well as increased aircraft speed. If these factors are to have a significant impact on results, it must be during these peaks.

Figure 10-26, which shows the same data as a cumulative function over the entire war, reflects the fairly consistent demand rate from day 12 on. It should also be noted that bulk accounts for nearly one third of the total tonnage, and nearly one fourth falls into the oversize and large categories. Almost half of the total tonnage is palletized. Palletized cargo has always been the bread and butter of tactical airlift, but this scenario emphasizes rolling stock to a much greater extent than the other scenarios. Since 25% of the tonnage is rolling stock, this scenario more than any other could influence the size of the cargo box. One final observation is that the level of fuel airlifted is only 5% of the total tonnage because of the availability of fuel in-country.

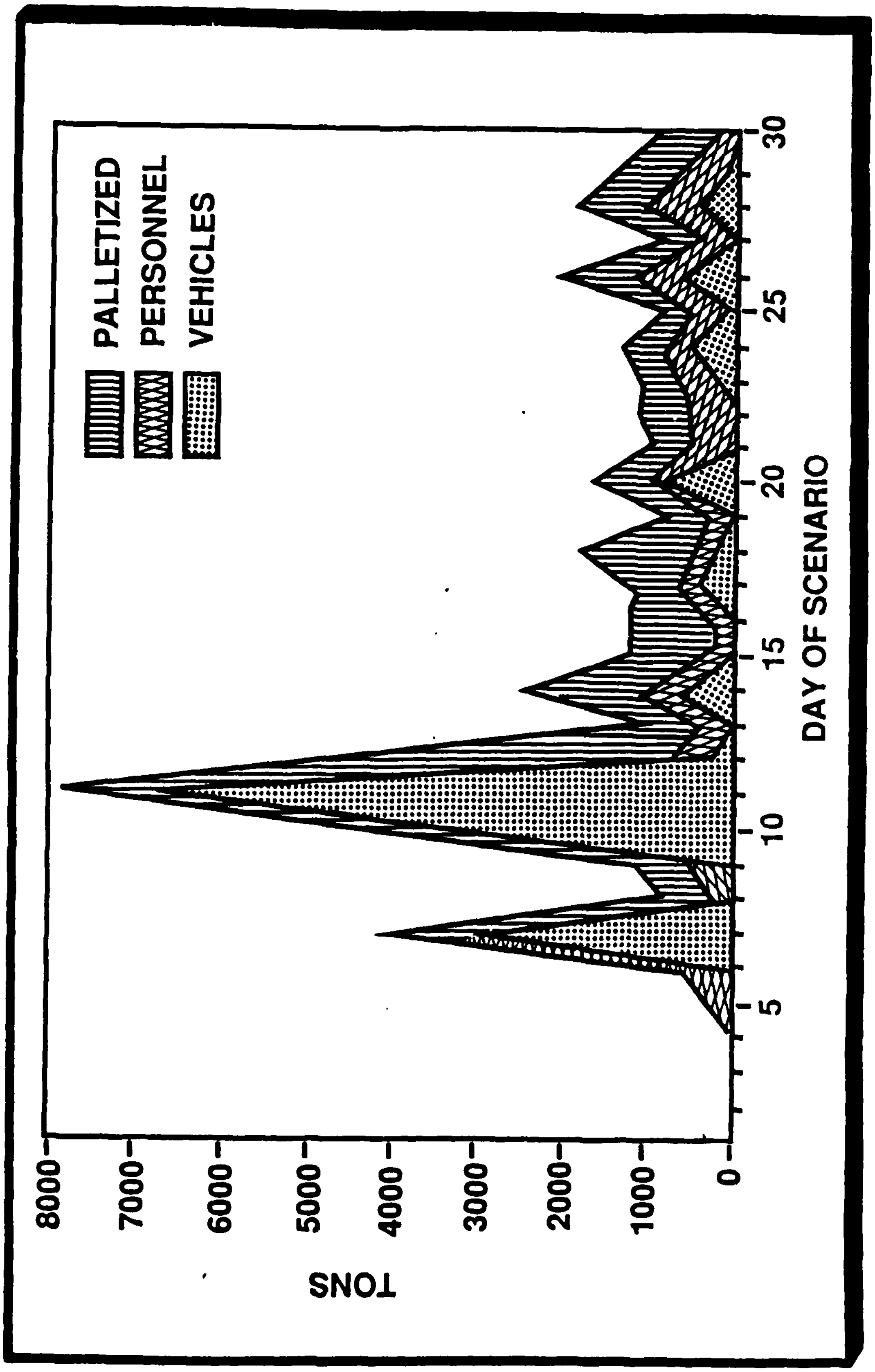



Figure 10-25. SWA Tonnage Required by Day.

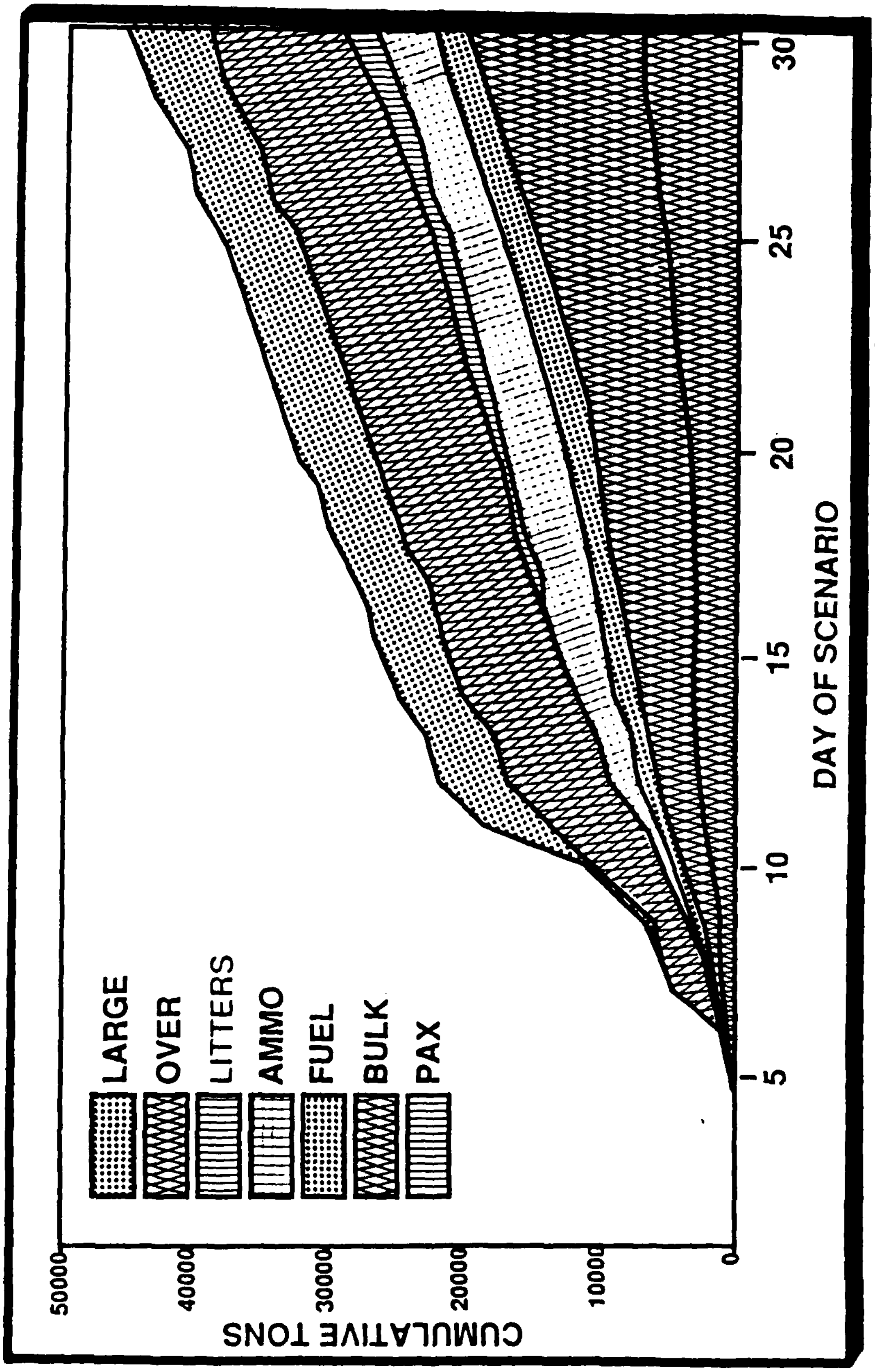



Figure 10-26. SWA Cumulative Required Tonnage.

Figure 10-27 summarizes the Central American total job set for the first 30 days of combat. Not surprisingly, the average cargo size is much smaller (23 tons) than that for the European and SWA scenarios with a much lower total demand (9,700 tons). The cargo mix for this job set has a higher percentage of pallets than either of the other sets.

- 430 TOTAL JOBS
- DEMAND IS 9,700 TONS
  - 19% PAX
  - 55% PALLETS
  - 25% VEHICLES
- 16 PRIORITIZED JOB TYPES
  - 4 - 24 HRS CLOSURE
  - 23 AVERAGE TONS PER JOB
- 43 ENTRY/DELIVERY SITES
- 33 AIRFIELDS
- 1 BEDDOWN AIRFIELD

Figure 10-27. Central America - Total Job Set.

Figure 10-28 shows the daily tonnage requirements for the Central American scenario. Total daily tonnage significantly ramp-ups on days 10 through 14, followed by a huge demand spike at day 15. It is during this period that units of a supply and service battalion are being moved, with completion of both occurring on day 15. Days 14 through 21 stress the airlift fleet, as the demand is at its highest level, with two very large peaks. After this period, the demand begins to drop off, with a large "ramp-down" during days 28 to 30. The average total daily demand is depicted on the figure at 490 tons/day. This is the total scenario tonnage divided by 20, the number of days of significant airlift activity. This average daily demand is equivalent to approximately 100 daily C-130H sorties, as the typical C-130H sortie carries 10 tons, and as a rule-of-thumb every productive sortie is associated with one unproductive sortie.

Figure 10-29 shows the same data as a cumulative function over the entire war. It shows that approximately 57% of all cargo tonnage is in palletized form (bulk, fuel, and ammo). Furthermore, approximately 26% of all demand is fuel.

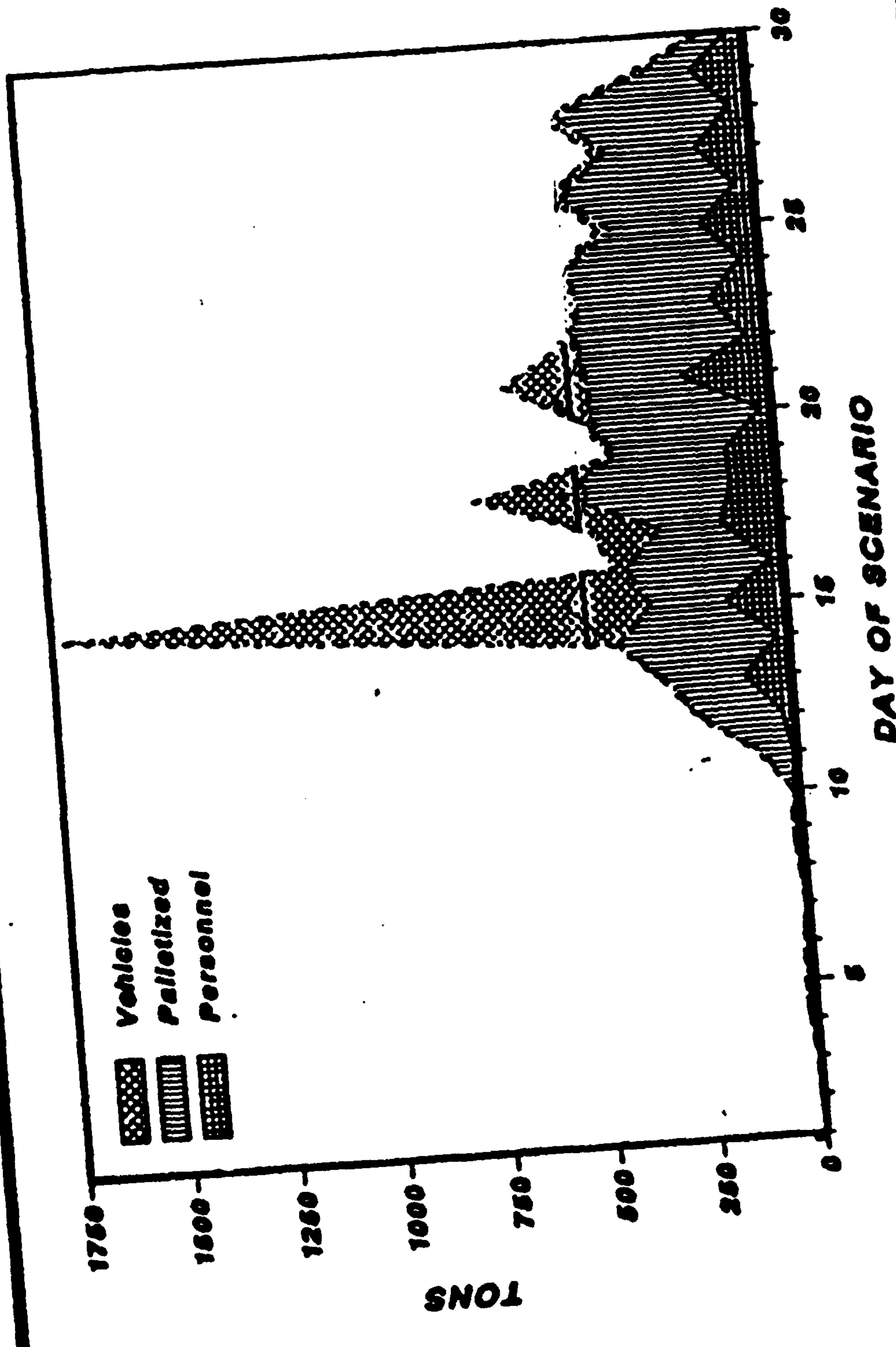



Figure 10-28. Central America Tonnage Required by Day.

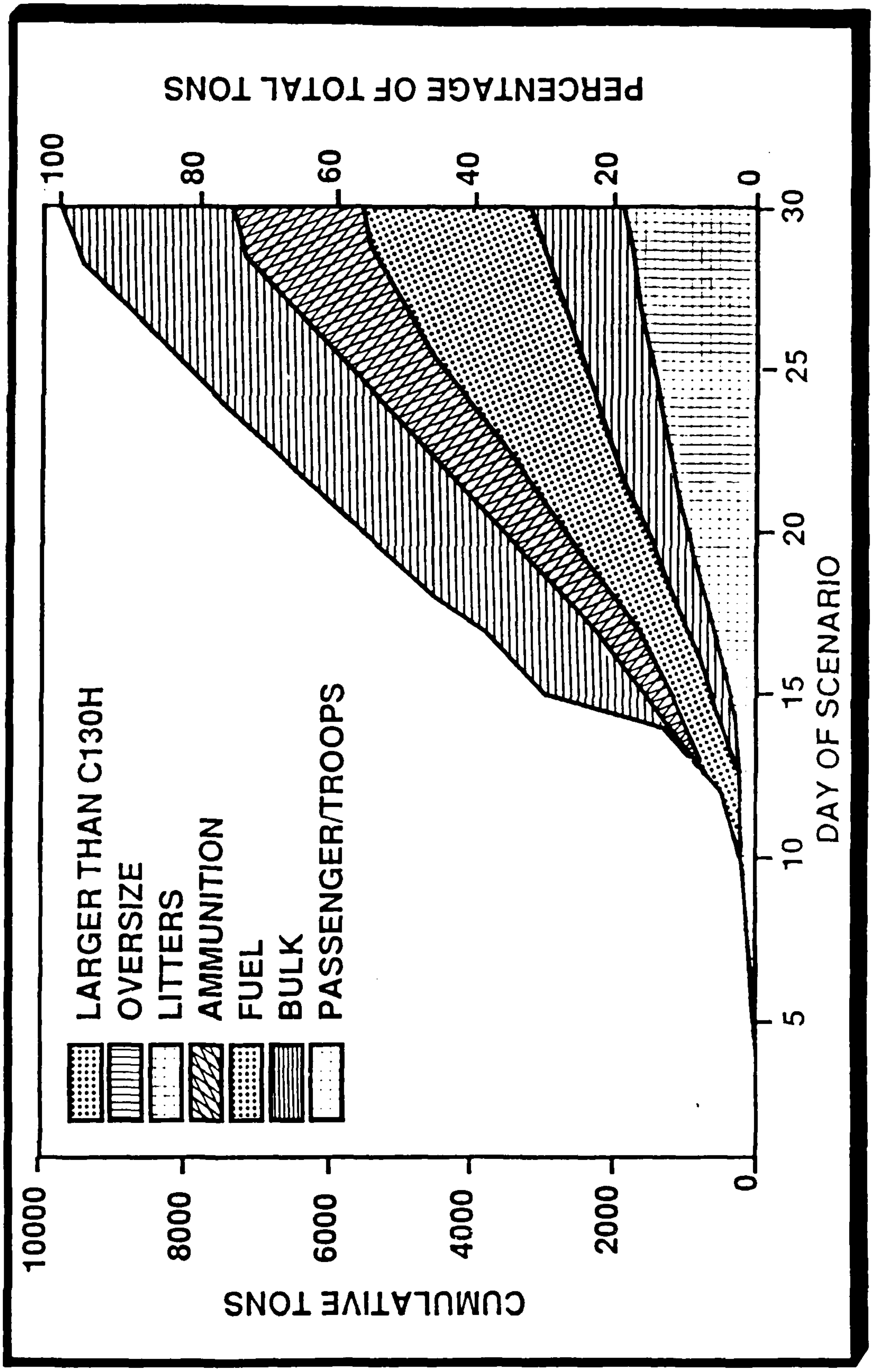



Figure 10-29. Central America Cumulative Required Tonnage.

Figure 10-30 provides a summary of all three job sets. Note that the values opposite each cargo category are expressed as a percentage of the total tonnage, and that bulk, fuel, and ammo are subcategories of pallets (i.e., the pallet percentage shown is the sum of the percentages for the three subcategories shown above it). The difference between the scenarios in the number of priority 1 and 2 jobs is also very apparent.

| | EUROPE | SOUTHWEST ASIA | CENTRAL AMERICA |
|---|---|---|---|
| **% OF TOTAL TONNAGE** | | | |
| PAX | 30 | 19 | 19 |
| BULK | 15 | 28 | 13 |
| FUEL | 11 | 6 | 26 |
| AMMO | 21 | 10 | 17 |
| PALLETS | 47 | 44 | 55 |
| VEHICLES | 23 | 37 | 25 |
| **% OF HIGH PRIORITY JOBS** | | | |
| PRIORITY 1-2 | 16.6 | 0 | 1.0 |
| PRIORITY 3-4 | 35.0 | 27.3 | 34.8 |

Figure 10-30. Job Summary.

## 10.5 DEFICIENCY ANALYSIS.

The deficiency analysis was the culmination of the needs analysis. It was an evaluation of the capability of the baseline force to perform the jobs established in the three scenarios described previously.

The objectives of the deficiency analysis were (1) to characterize the performance of the current intratheater airlifter, the C-130H, in terms of the year 2005 requirement; (2) to set a theater baseline for subsequent comparative evaluations; and (3) to gain insight on potential improvements to the intratheater airlift fleet.

The baseline force was established as a mix of the current C-130 and the soon to be fielded C-17. The C-130 aircraft were tasked first since the C-17 is primarily a strategic airlifter with a secondary role in tactical airlift. The C-17 was used only if C-130s weren't available or if the load was too big for the C-130. The C-130 fleet was sized so that the average sortie load would be 10 tons. The C-130's survivability evaluation was baselined with a suppression of enemy air defense (SEAD) campaign; standoff jamming; escorts to protect, divert, and dilute the threat; and a manual terrain following/terrain avoidance (TF/TA) capability to allow reasonably low level threat avoidance flight profiles under appropriate visibility conditions.

The NATO baseline results are shown in Figure 10-31. The graph illustrates the baseline statistics over the 30-day period. Note that 79% of the total required tonnage is delivered during the period with only 55% of the total arriving on time. For later comparison with new tactical airlifter concepts, the average delivery time, utilization rate, sortie percentage, and force attrition figures are also displayed. Of course, you should keep in mind that these statistics are useful on a comparative basis only and should not be considered to be predictive of actual combat results.

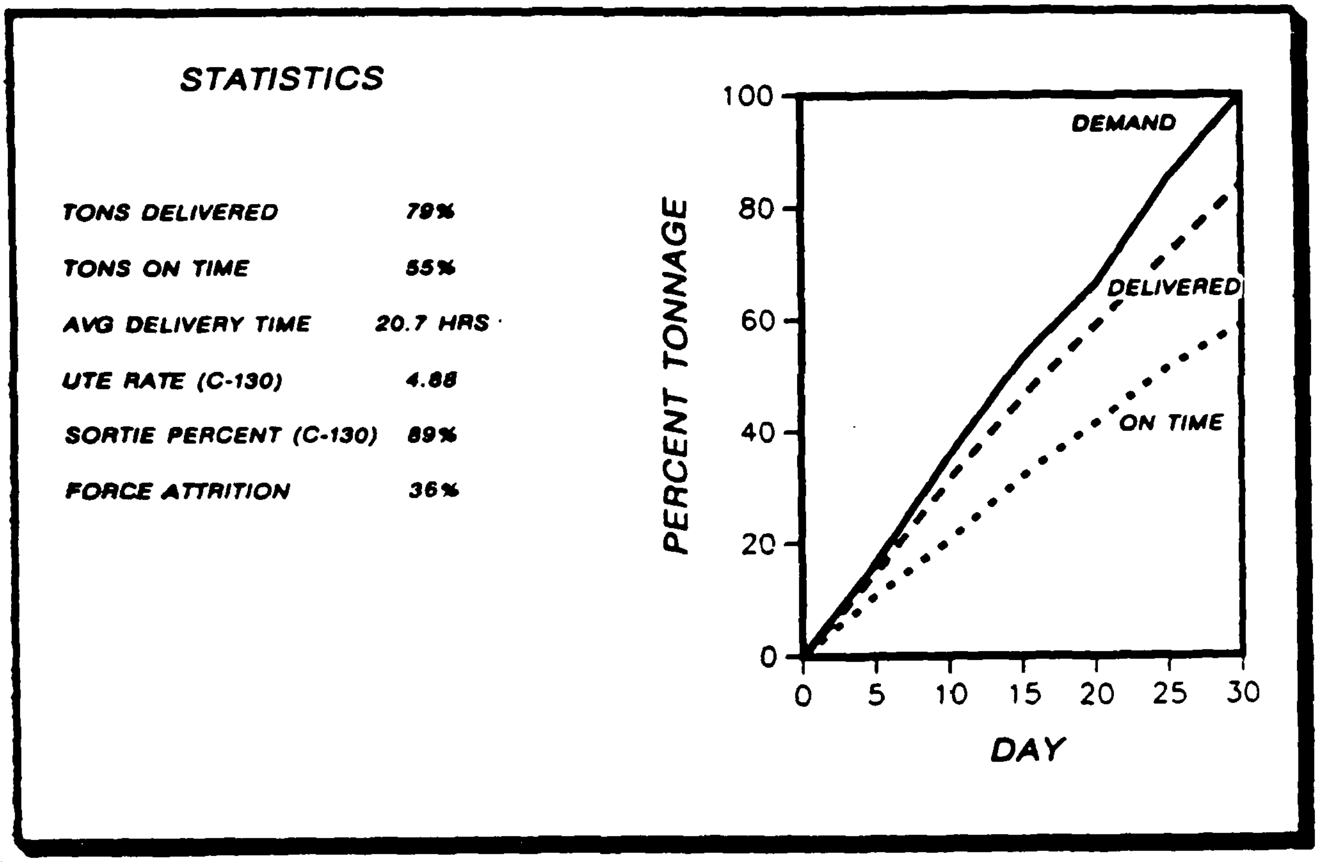



Figure 10-31. NATO - Baseline Results.

Similar baseline results for SWA are shown in Figure 10-32. In this scenario, the baseline force is able to deliver only 73% of the total tonnage required during the 30-day period, with only 35% of the total delivered on time. The utilization rate for this scenario is higher than for the NATO scenario primarily because of significantly longer sortie distances. The lower force attrition figure compared to NATO reflects a less severe threat to the airlifters.

***STATISTICS***

| | |
|---|---|
| *TONS DELIVERED* | *73%* |
| *TONS ON TIME* | *35%* |
| *DELIVERY* | *32.3 HRS* |
| *UTE RATE (C-130)* | *6.30* |
| *SORTIE PERCENT (C-130)* | *87%* |
| *FORCE ATTRITION* | *20.5%* |

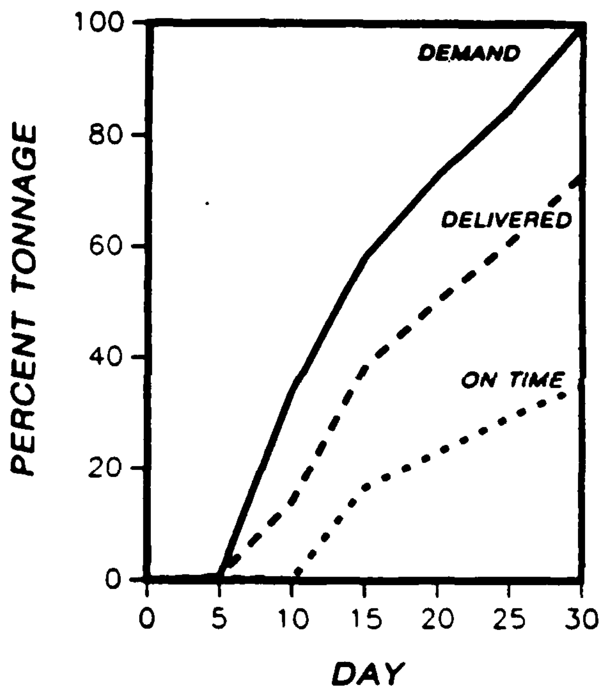



Figure 10-32. SWA - Baseline Results.

Finally, the baseline results for the Central American scenario are shown in Figure 10-33. Perhaps somewhat surprisingly, the percentage of total required tonnage delivered (51%) and on-time delivery (23%) is lower than either of the other scenarios. This is attributed largely to the relatively few suitable airfields available and their accompanying limitations. Not surprisingly, the very low threat to aircraft is reflected in very low force attrition.

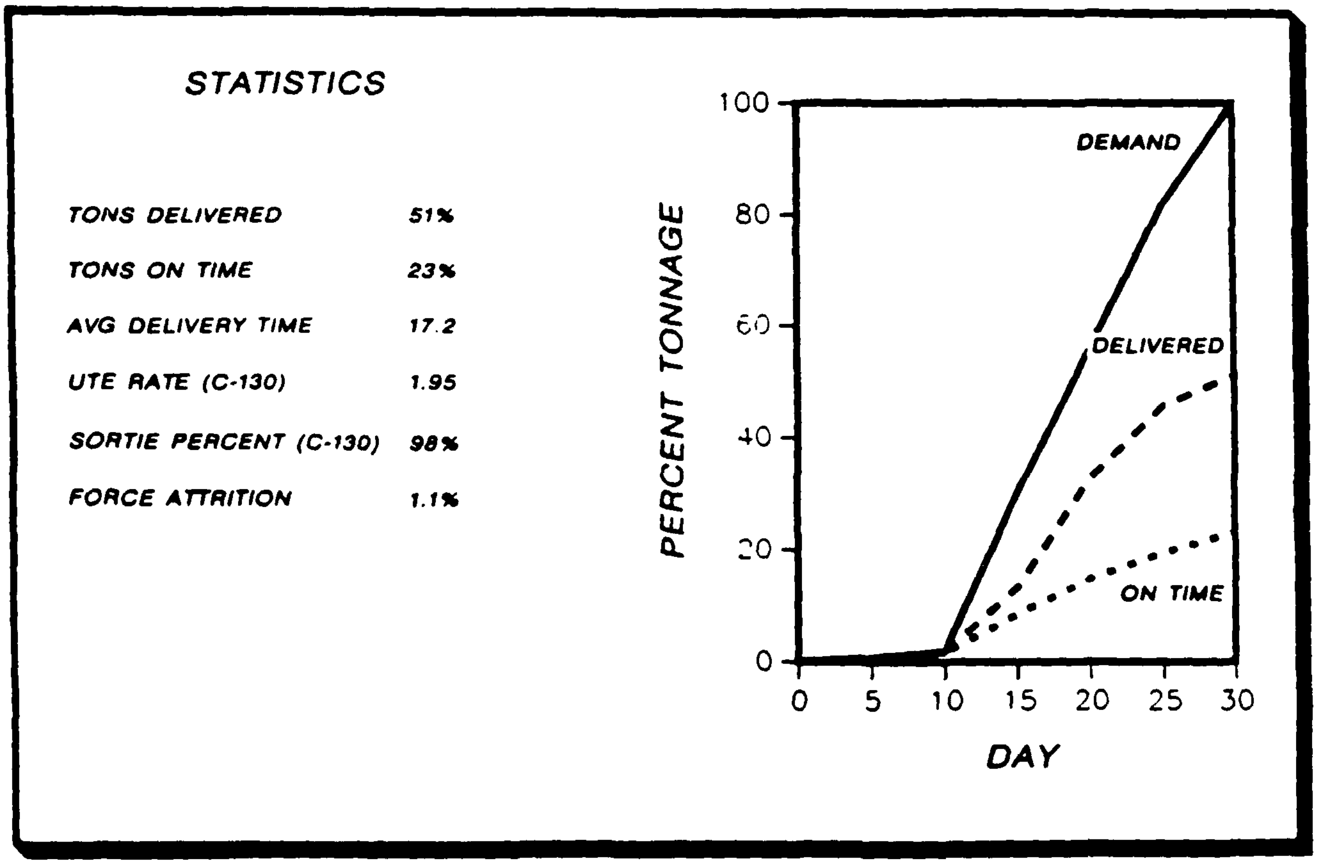



Figure 10-33. Central America - Baseline Results.

Highlights of the many conclusions drawn from this deficiency analysis are shown in Figure 10-34.

Increasing the size of the baseline force did not improve the overall performance of the fleet primarily because of airfield limitations with respect to the baseline aircraft.

Particularly in the NATO scenario, because of the high-threat environment, the C-130 fleet will suffer heavy attrition. Also, the C-130 fleet cannot generate adequate sortie levels day and night over the scenario period to adequately support short-notice high-priority moves required by the Army. However, the C-130 shortfall in delivering total tonnage and on-time delivery is not just because of the high attrition, but is attributable to shortcomings in many areas.

Although short field takeoff and landing capability is helpful, it is not as important by itself as runway durability (LCN), the degradation caused by operating at airfields in high temperature and pressure-altitude conditions, and degradation in cargo carrying capacity into and out of the short fields.

There is only a limited improvement to fleet effectiveness from improvement in any one area such as box size, survivability, reliability and maintainability, and short field performance. Significant improvement to the total airlift force will come from the right combination of improvements in the airlifters in several of those areas.

- INCREASING FORCE SIZE INEFFECTIVE

- SUPPORTING AIRLAND BATTLE WILL CAUSE HEAVY C-130 ATTRITION IN NATO

AND

- THE C-130 FLEET CANNOT ADEQUATELY SUPPORT SHORT-NOTICE HIGH-PRIORITY ARMY MOVES

BUT

- C-130 CLOSURE SHORTFALL IS NOT DUE TO ATTRITION ALONE

- SHORT FIELD CAPABILITY - ABSOLUTE TAKEOFF/LAND DISTANCES (BOTH VSTOL & STOL) ARE NOT AS IMPORTANT AS:
  - LCN
  - SHORT FIELD DEGRADATION AT TEMP/PA
  - CARRYING CAPABILITY DEGRADATION FOR SHORT FIELDS

- LIMITED PAYOFF FOR IMPROVEMENTS IN ANY ONE AREA
  - BOX SIZE
  - SURVIVABILITY
  - RELIABILITY & MAINTAINABILITY
  - SHORT FIELD PERFORMANCE, ETC.

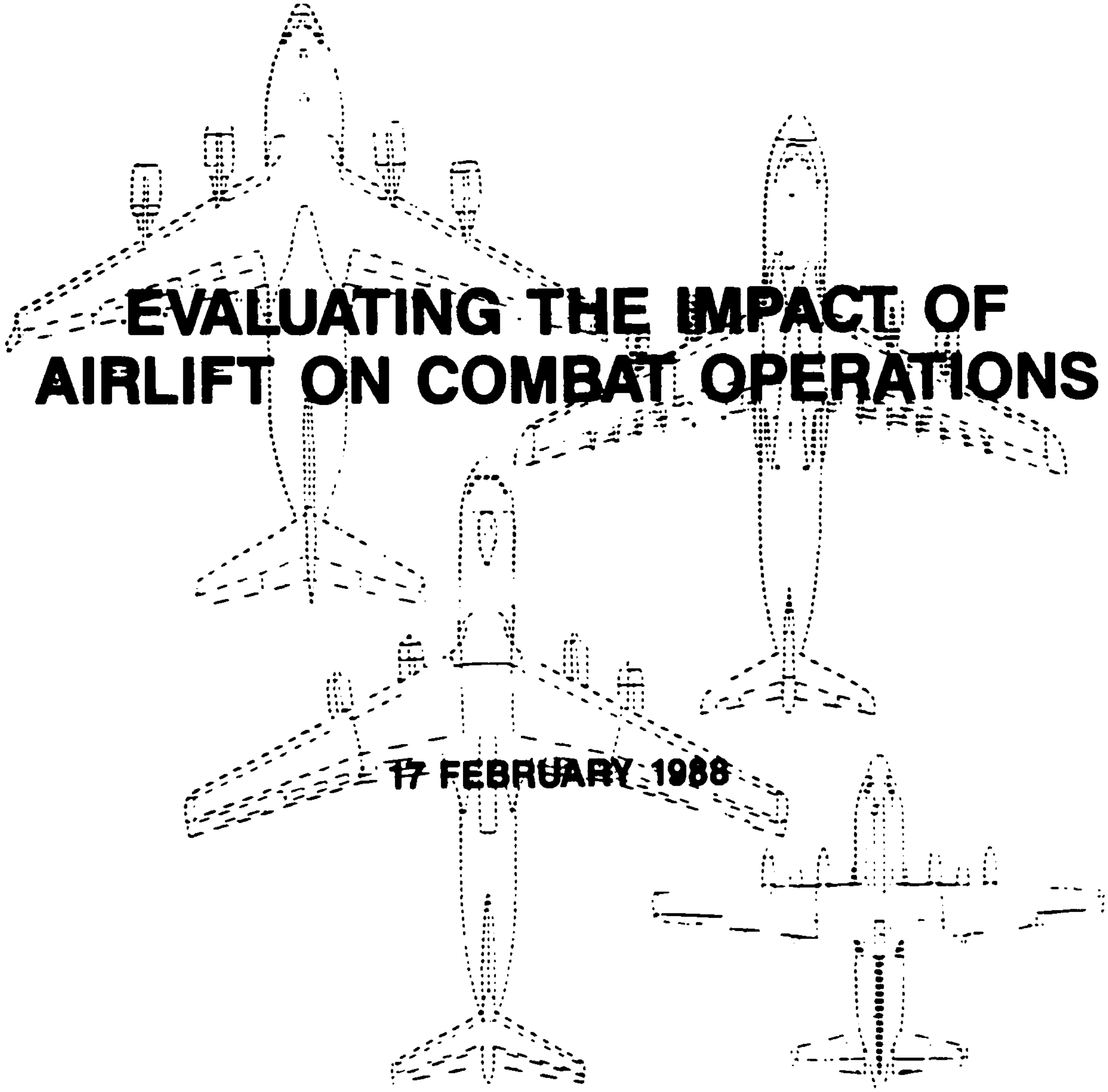
- FULL CAPABILITY WILL COME WITH THE RIGHT MEASURE OF IMPROVEMENT IN A NUMBER OF AREAS

Figure 10-34. Deficiency Analysis Conclusions.

Mr. Vukmir is a key member of the U.S. Air Force team which has been instrumental in guiding a massive advanced transport analytical effort to the benefit of the Air Force. He has spent his entire professional career at Wright-Patterson Air Force Base, including early military service working with analysis teams on advanced aero systems. He is currently Program Manager of the Advanced Transport Technology Mission Analysis - ATTMA.

Mr. Wourms is a leading analyst for the Advanced Transport Technology Mission Analysis, charged with performing the effectiveness analysis work for the project. He recently obtained an MS in engineering management, and is a registered professional engineer. His work experience has all been at Wright-Patterson Air Force Base, and includes experience in construction project management and foreign intelligence analysis.

CHAPTER 11



# EVALUATING THE IMPACT OF AIRLIFT ON COMBAT OPERATIONS

17 FEBRUARY 1988


**RICHARD C. LYONS**

**JOHN E. TIEHEN**


**Figure 1**

# EVALUATING THE IMPACT OF AIRLIFT ON COMBAT OPERATIONS

ABSTRACT: Evaluating the impact of airlift on combat operations requires the analysis of airlift as a mass flow rate of force. Airlift force may take the form of combat units, replacement equipment, support elements, or supplies depending on the scenario under evaluation. Combat simulations, using computer driven routines, must be sensitive to a broad spectrum of factors that range from weapon characteristics and equipment performance to logistics, tactical, and operational doctrine. The impact of airlift can then be measured and the results validated against benchmarked combat simulations and methodology.

Fielding modern armed forces is a dynamic cycle of development, deployment, maintenance, and training. The resources needed to sustain this cycle are scarce, and thus demand as much efficiency as possible from the cycle. In this light, the process of development is increasingly calling on the science of operations research to evaluate the effectiveness of new weapon systems, weapon improvements, modernizations, and force structures before changes and deployments, always at a much greater investment of resources, are made.

It is the purpose then of this paper to present a study methodology for evaluating the overall effectiveness contribution, or in short, the utility of new weapon systems. While that methodology can be readily applied to the evaluation of any weapon system, this paper will focus on evaluating airlift forces.

Evaluating the impact of airlift on combat operations requires the analysis of airlift as a mass flow rate of force. Airlift force may take the form of combat units, replacement equipment, support elements, or supplies depending on the scenario under evaluation. Operational scenarios are postulated to represent, as realistically as possible, potential use of the airlift fleet to support combat operations. Combat simulations, using computer driven routines, are then used to assess the outcome of military combat as a consequence of varying levels of airlift support.

The methodology for assessing the impact of different airlift options on the battle outcome, and the results of studies summarized in this paper, draw upon the wargaming expertise of LTV's Mission Analysis Center and the airlift experience of McDonnell Douglas Aircraft Company.

Disclaimer: The scenarios used in this presentation are a subjective representation of situations used as a background to study airlift. The scenarios are not associated in any way with the U.S. Department of Defense or any other government and should not be interpreted as representing contingency plans or as a forecast of future events. The sole purpose of the scenarios is to provide a hypothetical vehicle to illustrate the methodology for evaluating the impact of airlift on combat operations.

Force effectiveness is the broadest scope of combat analysis. It is beyond the single weapon system associated with one mission area. It is a number of weapon systems from all mission areas integrated into a unified force. The OBJECTIVE of a force effectiveness study is to quantify the benefit of a force change. The force change represented in this study results from three levels of airlift. The first level, or base case, is no airlift. Reinforcement, if any, is solely by road march. The second level of airlift considers reinforcement by the "Current Fleet" of airlift aircraft: C-5, C-141 and C-130. The third level looks at the "Future Fleet" of airlift aircraft: C-5, C-141, C-130 and C-17. The benefit of a force change will be at its greatest when the focus of analysis is force effectiveness rather than weapon or system effectiveness. A force effectiveness study flow is presented in Figure 2. It includes a scenario, a battle simulation, and an effectiveness evaluation, which is the interpretation of the battle outcomes in the battle simulation phase.

# FORCE EFFECTIVENESS STUDY FLOW

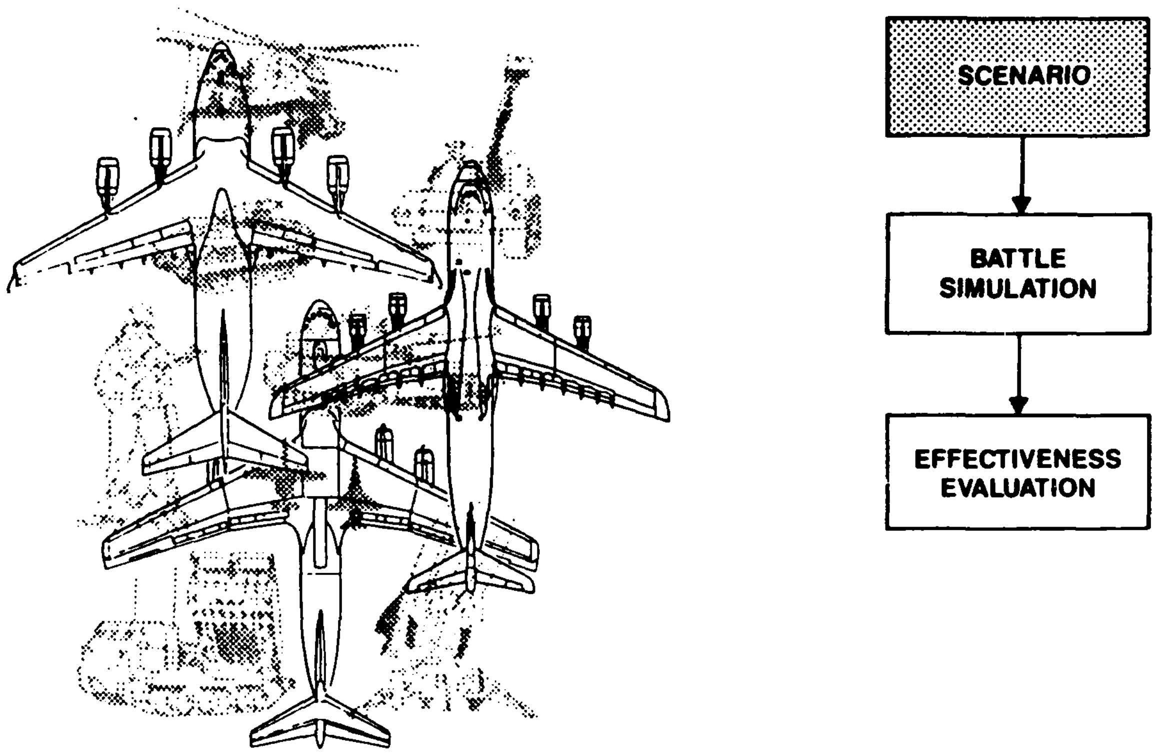



**Figure 2**

The scenario for a force effectiveness analysis includes the ground rules and assumptions, and the terrain, weather, and climate. In addition to the opposing forces and their deployments, reinforcement and replacement schedules, repair and reconstitution cycles, objectives and missions, elements of maneuver, tactics, and doctrine must be considered. The scope of the force effectiveness scenario is customarily large enough to justify analyzing many days of combat. The scenario developed for an Egypt/Libya study is presented in Figure 3.

The Libyan strategic plan is shown here. Advances are intended to follow the routes shown by the arrows. The operational concept is to use the Sidi Barrani/Mersa Matruh axis for the main force to push in no further than Mersa Matruh. This would be aided by a supporting attack that goes through Siwa

## SCENARIO – EGYPT'S WESTERN DESERT

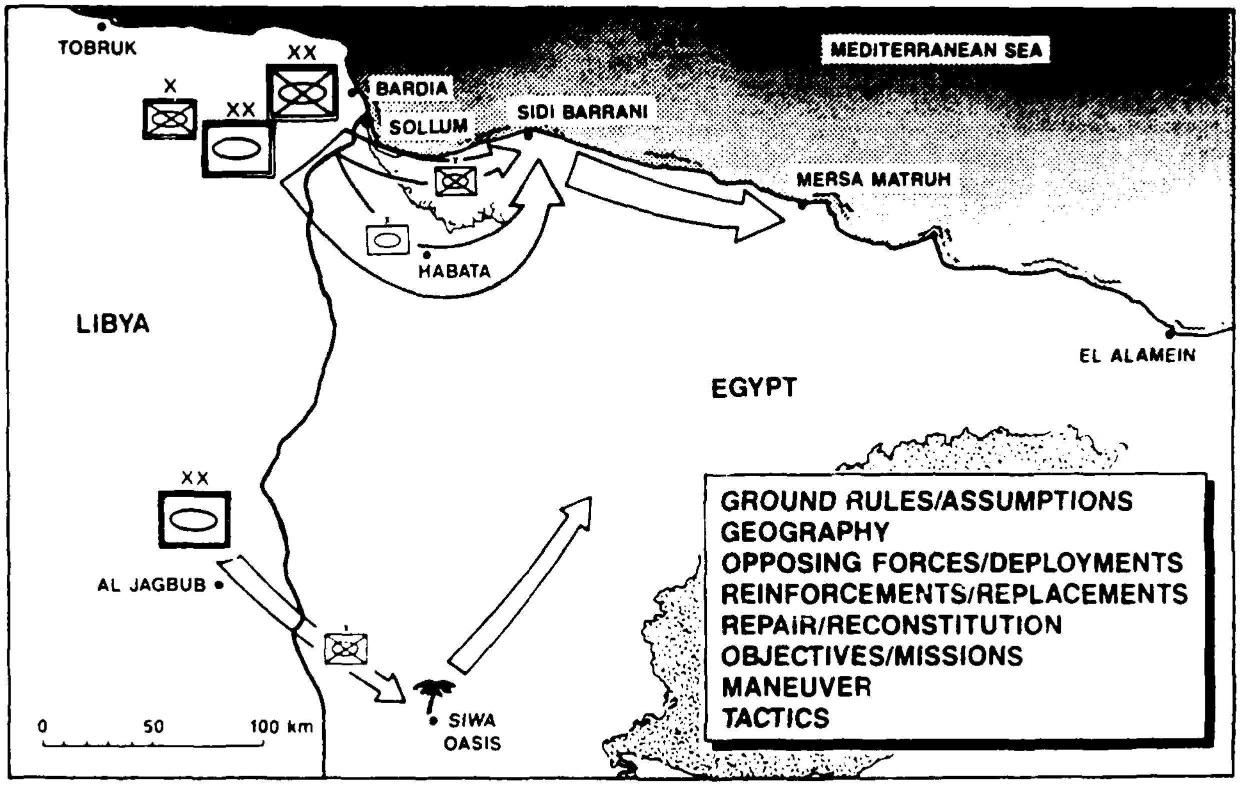



**Figure 3**

Oasis and feints north toward Mersa Matruh. The main purpose of this attack is to draw Egyptian forces from coastal operations, thereby diluting their forces. Although Libya has an enormous inventory of up-to-date weaponry from the Soviet Union and France, they do not have enough trained manpower to operate all of these complicated weapons systems. Therefore, Libya is limited by the effective size of its military force to a comparatively small adventure that might reach as far as Mersa Matruh. The main reason for embarking on such an adventure is solely for the political embarrassment of the Egyptian government and to further polarize the Arab world.

Three and one-third Libyan divisions are massed along the Egyptian border, two and one-third to the north and one to the south.

Defending against the Libyan forces are three Egyptian brigades patrolling along the border. One brigade is located on the coast road to the north. Another is on the road leading towards Habata, located slightly southwest of the first brigade. The third brigade is located between Siwa Oasis and the Libyan border.

These forces, in place at the beginning of battle, represent a 3.3:1 ratio (attacker-to-defender). It is assumed that the Egyptians are aware of the Libyan force buildup along their western border, but do not know when, or if, an attack will be made. In the event of an attack, the Egyptians plan to augment their border forces with additional forces from staging areas near Cairo West and request U.S. assistance. The U.S. responds to this diplomatic request and, within a day, positions military airlift aircraft at Cairo West airfield.

Reinforcement of the Egyptian Border Defense Units is made from the staging areas near Cairo West airfield. Three reinforcement options are evaluated. One by road march and two by airlift. The in-theater airlift reinforcement situation is depicted in Figure 4.

Initial Egyptian reinforcement planning commences prior to the start of the war based on intelligence estimates. The two desired destinations for Egyptian reinforcements are Sidi Barrani on the coast and the area near Habata airfield on the inland plateau to the south.

A total of 5,849 tons are to be moved to Sidi Barrani, including one mechanized brigade and its support and resupply. A total of 12,642 tons are to go to Habata, including one tank brigade, one mechanized brigade and the accompanying support and resupply for those two units.

# IN-THEATER AIRLIFT REINFORCEMENT

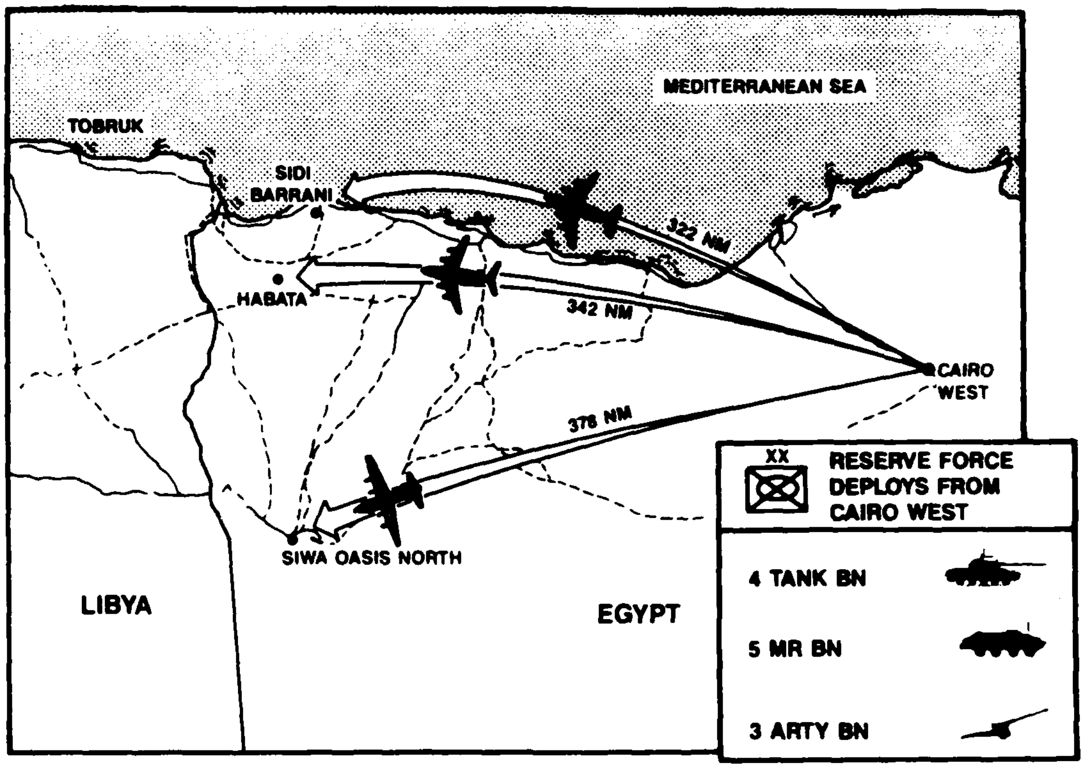



Figure 4

As the wargame evolves, these plans will change en route for two of the three reinforcement cases considered. These shifts are in response to the Libyan plateau advance and the resulting tactical situation. Only the future airlift fleet can follow the complete plan. However, no reinforcement is cancelled in any of the cases studied.

In addition to the units deployed to Sidi Barrani and Habata, 1,198 tons of resupply (959 tons ammunition and 239 tons nonammunition resupply) are destined for Siwa Oasis further south to resupply a mechanized brigade by Egyptian Air Force C-130s. The Libyan incursion at Siwa Oasis is noted but not examined further in the study.

All in-country airlift sorties originate at the Cairo West airfield. U.S. Air Force aircraft shuttle Egyptian men, equipment and supplies to the two forward airfields at Habata and Sidi Barrani. Airlift using the C-5, before the C-17 enters the fleet, is contrasted to airlift with the C-17 only. Both cases attempt to airlift the same cargo from the Cairo area to the same two destinations.

The two destination airfields used in the study (see Figure 5), Sidi Barrani and Habata, were selected because of their proximity to the battle area. Friendly control of Egyptian airspace is assumed.

Sidi Barrani airfield is located 16 kilometers south of the city of Sidi Barrani which is on the northern coast. The airfield itself is characterized by one long runway (9,943 feet) and a 60-foot wide parallel taxiway, with

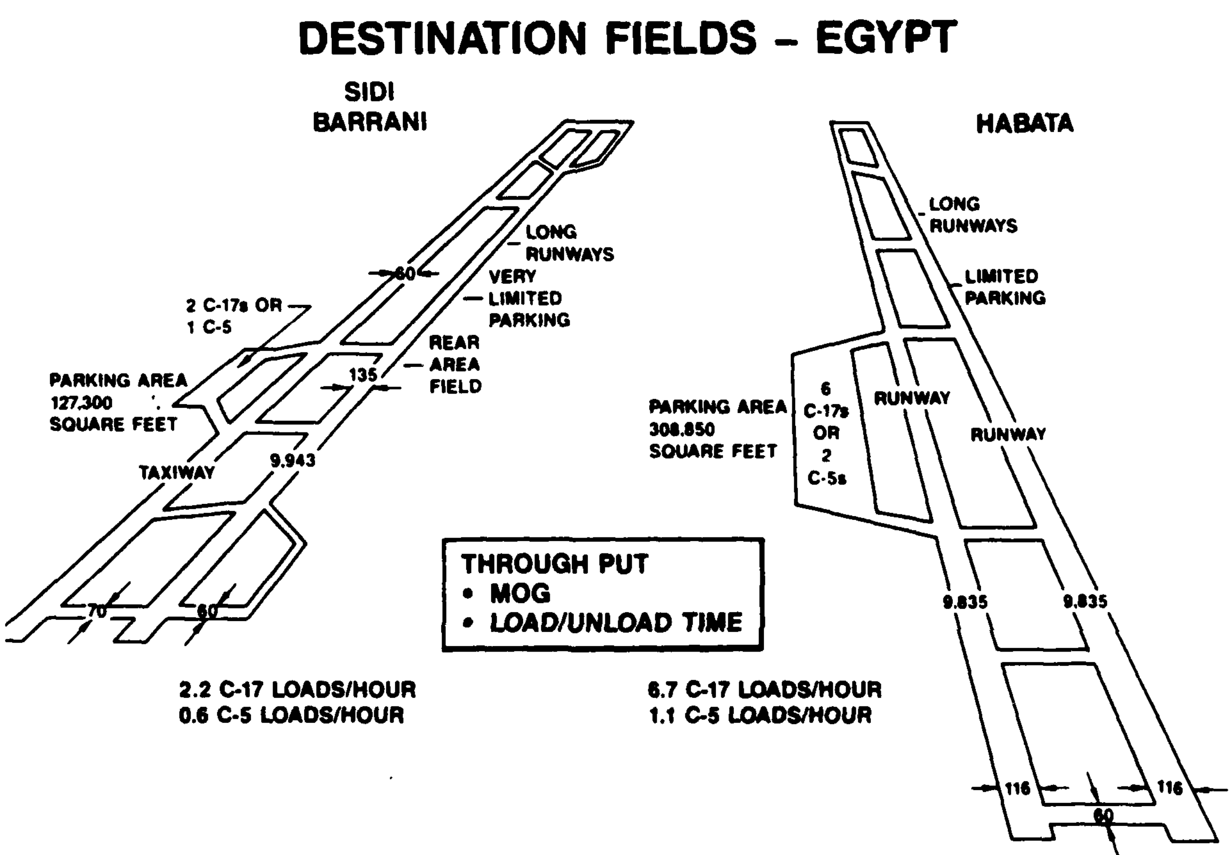



Figure 5

shorter, narrow connecting taxiways throughout. Parking analysis of the unusually small parking apron (127,300 square feet) shows that the maximum-on-ground (MOG) aircraft is limited to one C-5 or two C-17s at a time.

Habata airfield is located 75 kilometers southwest of the city of Sidi Barrani in a high plateau region. This airfield is characterized by two long parallel runways (9,835 feet) with seven narrow connecting taxiways. Habata's double entry parking apron is somewhat larger than the apron at Sidi Barrani, but relatively small at 308,850 square feet. Six C-17s or two C-5s can park at Habata at one time.

The results of the three reinforcement cases are shown in Figure 6. The bottom line in the mass flow rate of force is "When do the reinforcements join the battle and what is their strength?" In all cases, the first day of the war is required for organization and preparation. Actual road march or airlift begins on D+1 or the second day of the war.

In the "No Airlift" case, three Egyptian brigades are road marched to reinforce the border brigades defending against the two northern Libyan penetrations. Readiness times for the three brigades, including assembly times, are:

| | | |
|---|---|---|
| Tank Brigade | Day 2 | 0500 |
| 1st Mech Brigade | Day 2 | 1300 |
| 2nd Mech Brigade | Day 3 | 0500 |

# SCHEDULE OF UNIT ARRIVALS INTO BATTLE

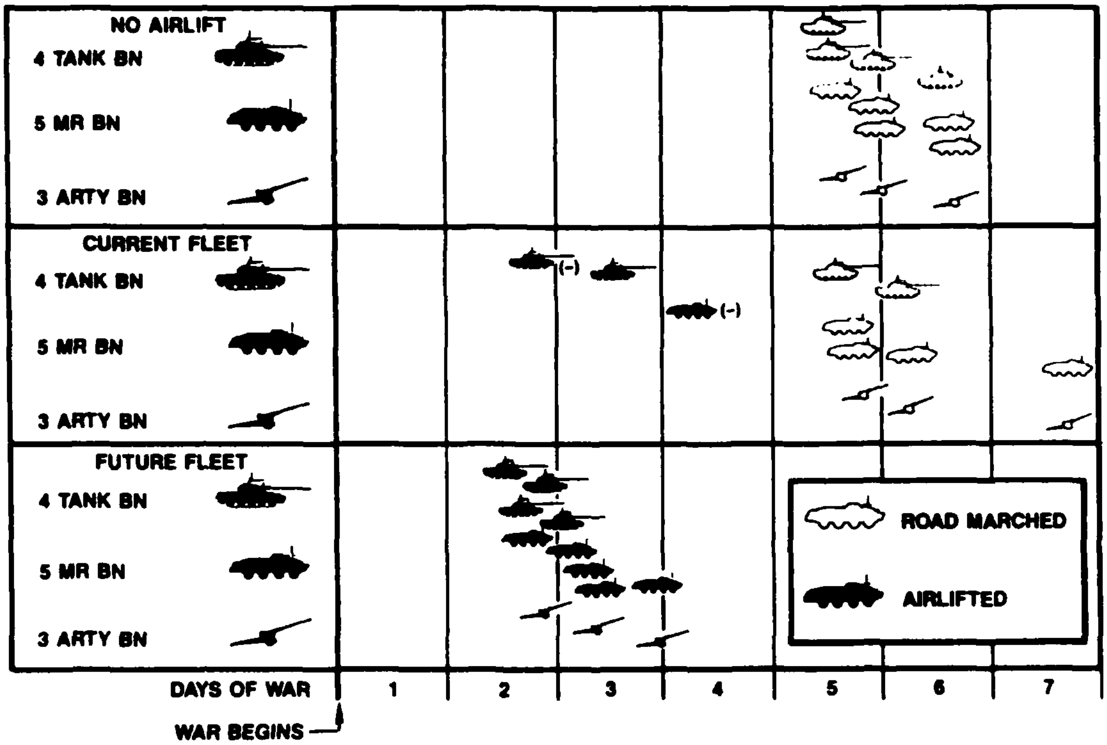



**Figure 6**

The tank brigade departs the Nile Delta region near Cairo at first light on the second day of the war. It arrives on day 5 of the war and is committed against the coastal Libyan thrust; the most critical of the Libyan penetrations at that time. The two subsequent brigades are then committed against the Habata plateau penetration on days 5 and 6.

The consequence of airlift with the current fleet is, that even though the initial units airlifted to the battle area join the battle on the afternoon of day 2, the reinforcements do not arrive fast enough to stop the advance and prevent loss of the airfields. Consequently, the remaining reinforcement must be road marched and join the battle on days 5, 6 and 7, as shown in Figure 6.

The "Future Fleet" is represented by 60 C-17 aircraft which deliver all three Egyptian reinforcing brigades from Cairo West to Habata and Sidi Barrani in 1.7 days.

The first of the three battalions airlifted to Sidi Barrani is committed shortly after midnight on day 3. This commitment time accounts for road march from the airfield to the battle and a four-hour preparation time for refueling and arming. The last battalion is committed to the coastal battle before daybreak on day 4.

More C-17 parking and a greater flow rate at Habata allows all three battalions of the tank brigade to be committed by the end of day 2, the day the airlift begins. The mechanized brigade is also committed by the middle of day 3.

The limiting factor in the mass flow rate of force in reinforcement is the service rate in the ground portion of the transportation network. In the "No Airlift" case it is the average convoy speed of slightly over 13 kilometers per hour and a limit of 13.7 driving hours per day imposed by the poor roads and trails available across the desert and coastal plain. In the airlift cases, the limit is throughput constraints imposed by the forward airfields. That is the limit due to the maximum number of aircraft on the ground and their time to load/unload. We assumed the fleet size required to provide the airlift would be available. For this study it turned out that 18 C-5s and 60 C-17s could perform the airlift.

A force effectiveness study flow is presented in Figure 7. It includes a scenario, a battle simulation and an effectiveness evaluation.

# FORCE EFFECTIVENESS STUDY FLOW

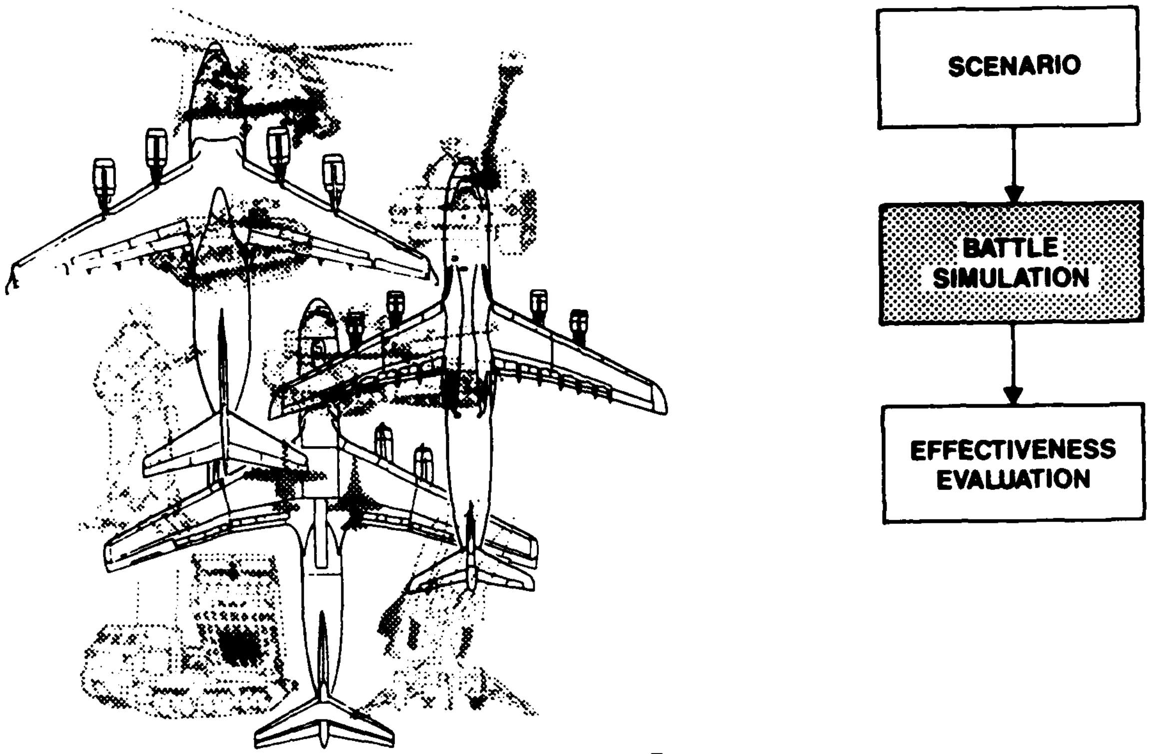



Figure 7

The battle simulation begins with the reinforcement plan, doctrine, tactics, missions, and objectives of the opposing forces. Next, a tactical decision process for engagement is entered, leading to the combat interactions of all of the opposing forces in all mission areas. Inputs from weapon and system effectiveness analyses contribute to the resolution of combat. From the combat interactions, each side assesses the effects of the combat, establishes a new "perceived" situation, makes new tactical decisions and returns to combat. This cycle is controlled by each side's respective command and control network. However, since the effects assessment on enemy forces as the result of combat is only perceived, and is thus imperfect, the actual result of combat on the enemy is fed back into

the combat interactions in the next cycle. This cycle is repeated throughout the length of the simulated engagement, perhaps over days or weeks. This battle simulation cycle is illustrated in Figure 8.

## BATTLE SIMULATION METHODOLOGY

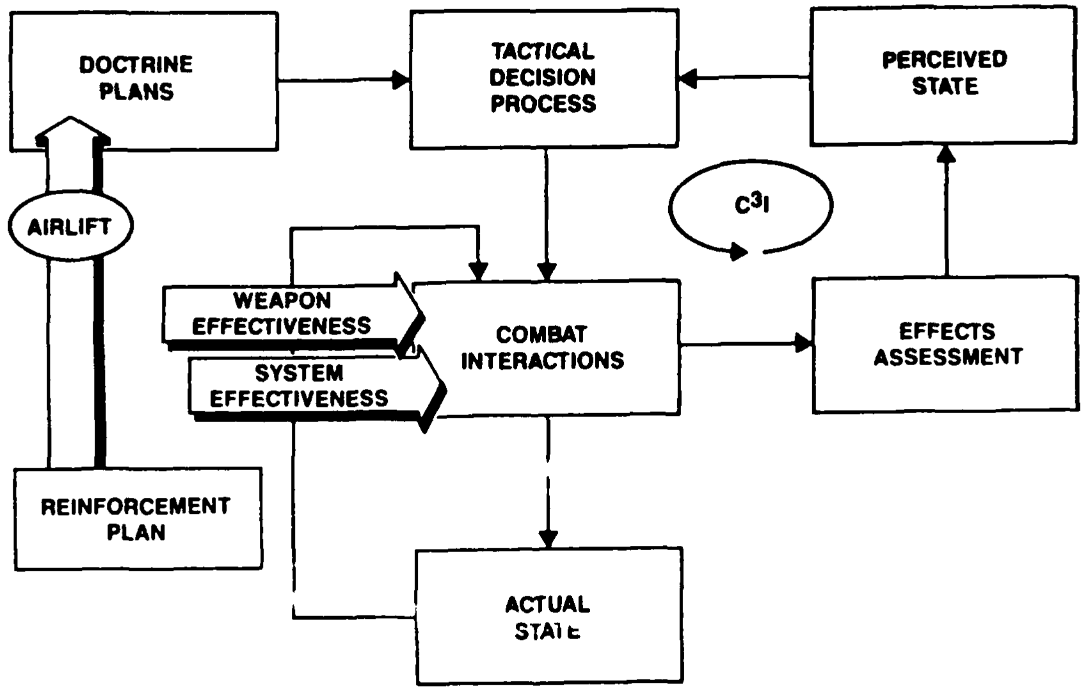



**Figure 8**

The foundation of the methodology is combat simulation to generate the battle results. Two models have been used throughout our airlift analyses. Each has distinctive characteristics making it particularly suitable for the studies listed (see Figure 9).

The Military Analysis Rapid Simulator (MARS) was derived by LTV from the Quantified Judgment Model (QJM). Initial input incorporates a scenario, opposing forces and the objectives of the attacker and defender. More detailed data is then collected and inserted into the data base considering

# COMBAT MODELS

**Military Analysis Rapid Simulation (MARS)**

- **Egypt/Libya**
- **Honduras/Nicaragua**

**Corps Tactical Airland Battle Simulation (CORPS TABS)**

- **Korea**
- **Southwest Asia**
- **Central Europe**

**Loadmaster Type Loads**

**Figure 9**

such things as numbers of weapons, troops, etc. Similarly, other operational factors and geographical considerations are input and handled by algorithms within the model. Combat between the two sides is played over a preselected number of days.

The CORPS TABS combat simulation model was derived by LTV from the VECTOR-2 force on force simulation model. Initial input incorporates a scenario, opposing forces, and the objectives of the attacker and defender. Detailed weapons data is collected and inserted into the data base for weapons effectiveness computations. Similarly, operational factors governing tactics, logistics, and decision rules are formulated to govern the sequence of events in the simulation. Environmental and geographical features are input into the model and are used for line-of-sight calculations, fly or no-fly decisions, logistics flow, etc. Combat

simulation between the two sides is run over a preselected number of days; the output may be sampled at desired intervals during the period simulated. The results of the model are expressed in territory lost or taken, advance rates, weapons system losses, losses attributed to a type of weapon system and force exchange ratios. A number of output measures are usually analyzed simultaneously to gain a more comprehensive understanding of the forces' status and to ascertain which weapon system, tactics, or rules have significant impact on battle outcome.

The airlift performance data was provided by Douglas Aircraft Company. The Loadmaster Type Loads model was used to produce input data for the battle simulation models.

The force effectiveness study flow is presented in Figure 10. It includes a scenario, battle simulation and an effectiveness evaluation.

The force effectiveness evaluation blends the dynamic interaction of the basic opposing force elements (armor, infantry, artillery, and air) with some delta force increase from reinforcement to determine the effects on enemy and friendly forces. This theme is shown in Figure 11. The general effect on the enemy will be to inflict more attrition, to cause delays, and to make the enemy generally less effective. Inversely, friendly forces will suffer less attrition, thereby having more opportunity to seize the initiative while being generally more effective.

## FORCE EFFECTIVENESS STUDY FLOW

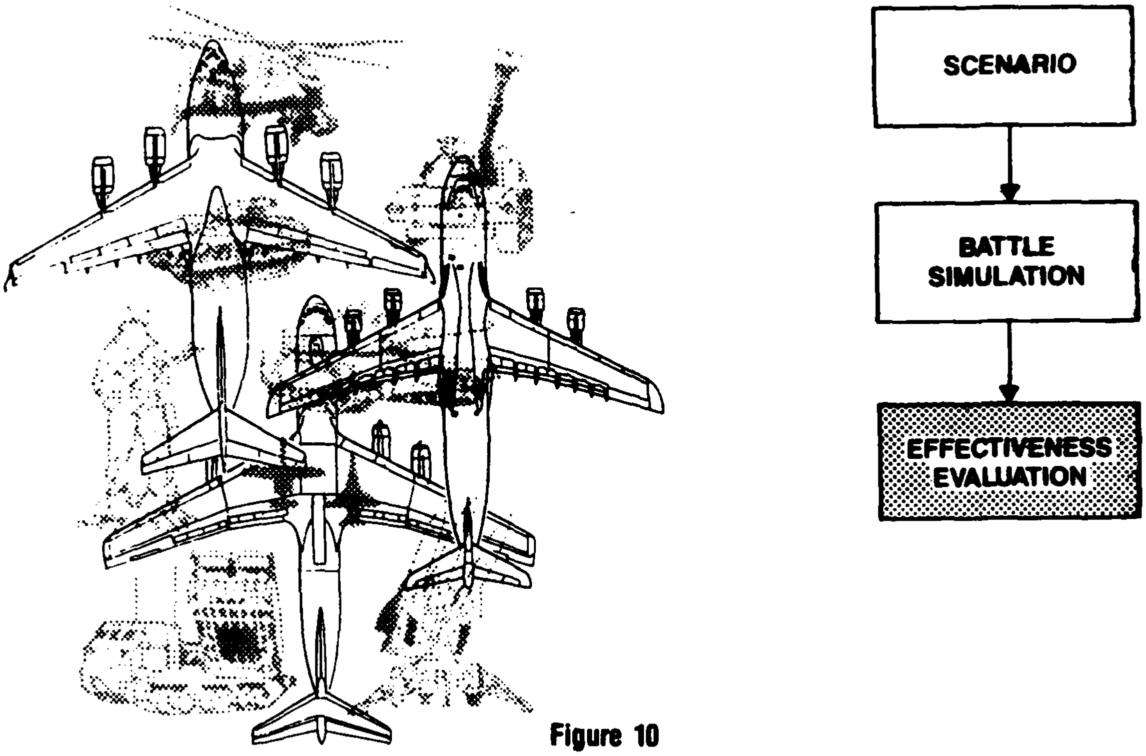



Figure 10

## EFFECTIVENESS EVALUATION

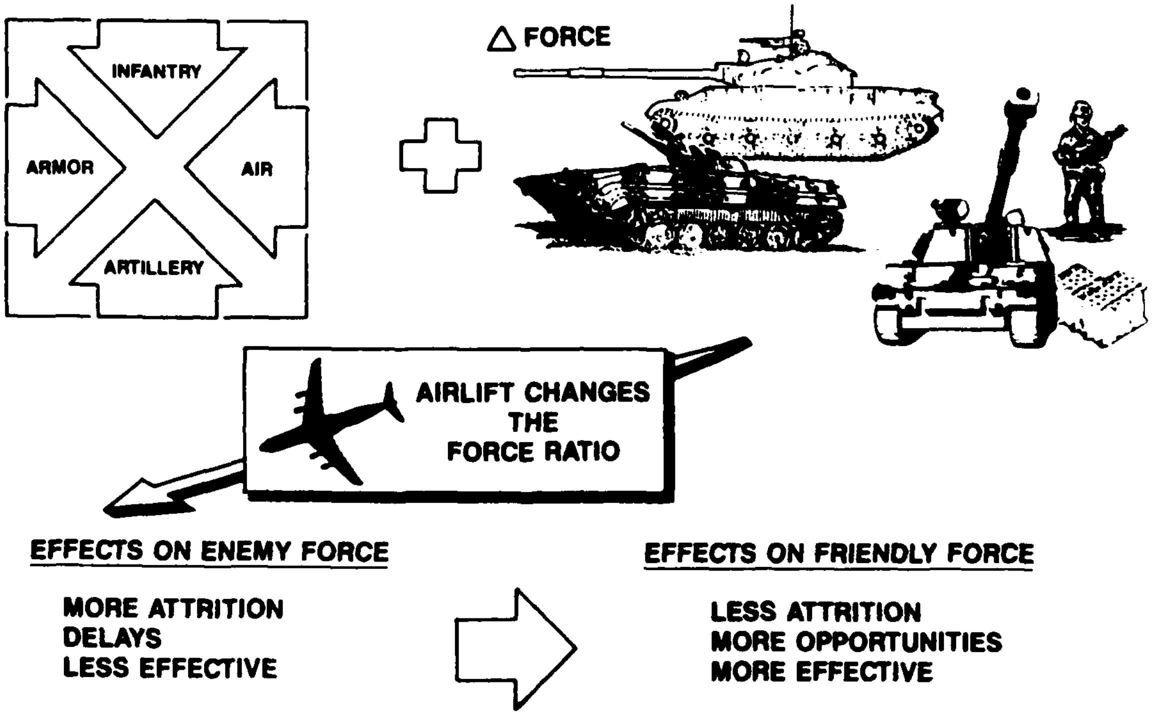



Figure 11

There is a wide variety of results that can be used as measures of force effectiveness, as highlighted in Figure 12. An accounting of surviving forces and attrited forces by type, as well as corresponding exchange ratios, is very useful. These measures should be examined by day and as sum totals at the end of the battle. Loss attributions, the weapons responsible for attrition, provide key insights to specific weapon contributions. The relative combat power between the opposing forces reveals the gross level interactions of the two sides. The depth of penetrations and ground lost or taken, as measured by a daily trace of the Forward Edge of the Battle Area (FEBA) or the Forward Line of Troops (FLOT), as well as a record of the objectives achieved are also useful. These measures of effectiveness apply to one case, as in system effectiveness, and a matrix of analytical cases can be explored for variable

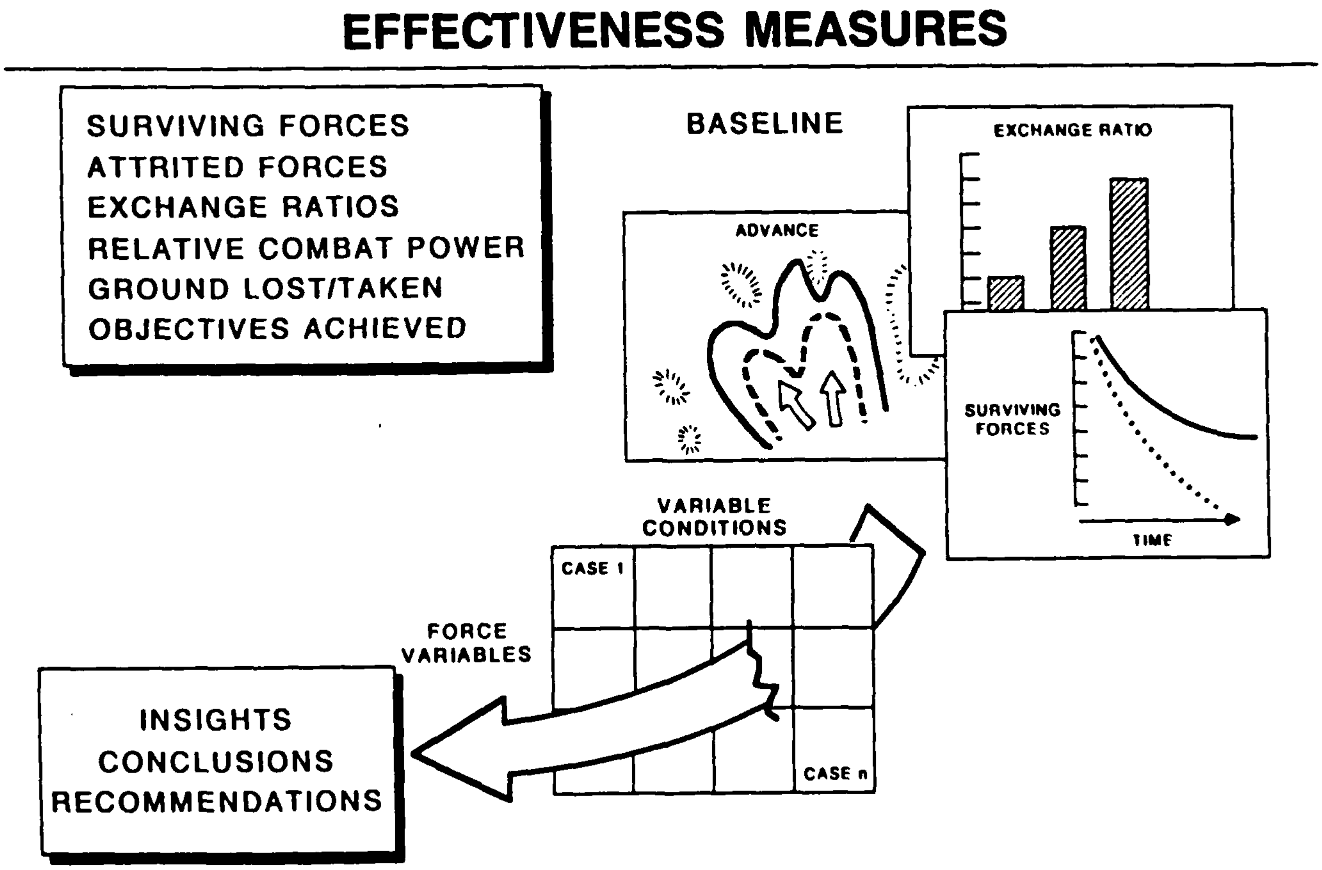



Figure 12

operating conditions as well as for variations in reinforcement to yield insights and conclusions suitable for airlift decisions.

Effectiveness results selected to illustrate this method for analyzing airlift operations are related to the limited objectives of the Libyans. Recall that their objective was to embarrass the Egyptians by capturing Sidi Barrani and advancing to Mersa Matruh. Blocking the Libyan advance and limiting the ground they occupy is a counterobjective of the Egyptians. The day-to-day trace of the Libyan advance is the measure selected to evaluate the battle results and assess the impact of force changes related to the three options for reinforcement. The road marched reinforcement case is illustrated in Figure 13 for a reference.

**ROAD MARCHED REINFORCEMENTS: SIDI BARRANI UNDER FIRE FROM BOTH LIBYAN THRUSTS**

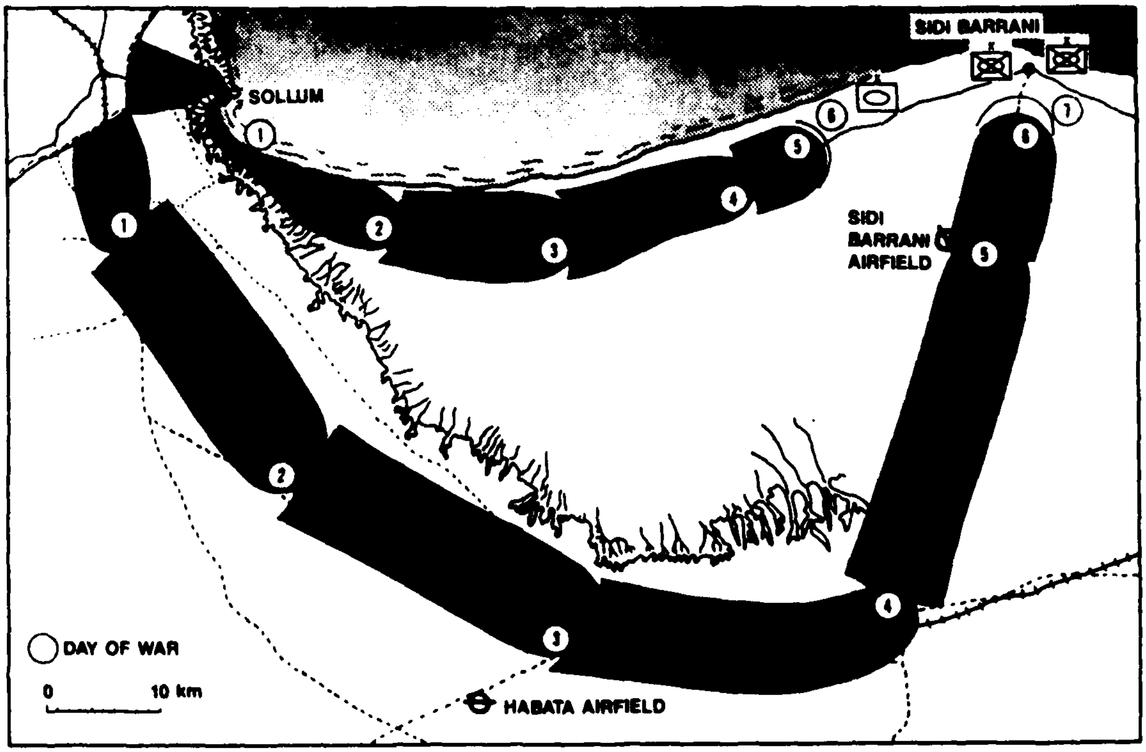



Figure 13

Although the Libyan advance is halted, road marched reinforcements arrive too late to save either Habata or Sidi Barrani airfields. In addition, Egyptian forces are confined in a narrow corridor near the city of Sidi Barrani. This concentration of forces provides a target rich environment for both Libyan mortar and artillery fire as well as attack helicopters using Habata airfield as a forward operating base.

The tank brigade stopped the Libyan advance on the coast 15+ kilometers from Sidi Barrani, but this left Libyan artillery and multiple rocket launchers well within range of the city. The two mechanized brigades also stopped the Libyans on their advance from the plateau, but in that case, the Libyan troops were so close that even mortars could shell the city. Other weapons, such as 122-millimeter howitzers, 130-millimeter field guns, and BM-21 and BM-27 rocket launchers, could easily concentrate barrage fire over the city and the Egyptian defensive positions remaining along the coast. In short, this would leave the Egyptian forces in a state of seige reminiscent of Tobruk in World War II.

The payoff for reducing the time required for reinforcements to join the battle is illustrated in Figure 14 for the two airlift cases, current fleet and future fleet. The current fleet with C-5s halts the coastal advance on day 5 and the plateau advance on day 7. Even so, Habata airfield is lost and the city of Sidi Barrani and the airfield are within range of Libyan artillery. The future fleet delivers reinforcements early enough to turn the battle in the first few days. The coastal advance is halted on day 5 and the plateau advance is halted on day 3. The C-17 case is the most desirable since

# COMPARISON OF BATTLE RESULTS

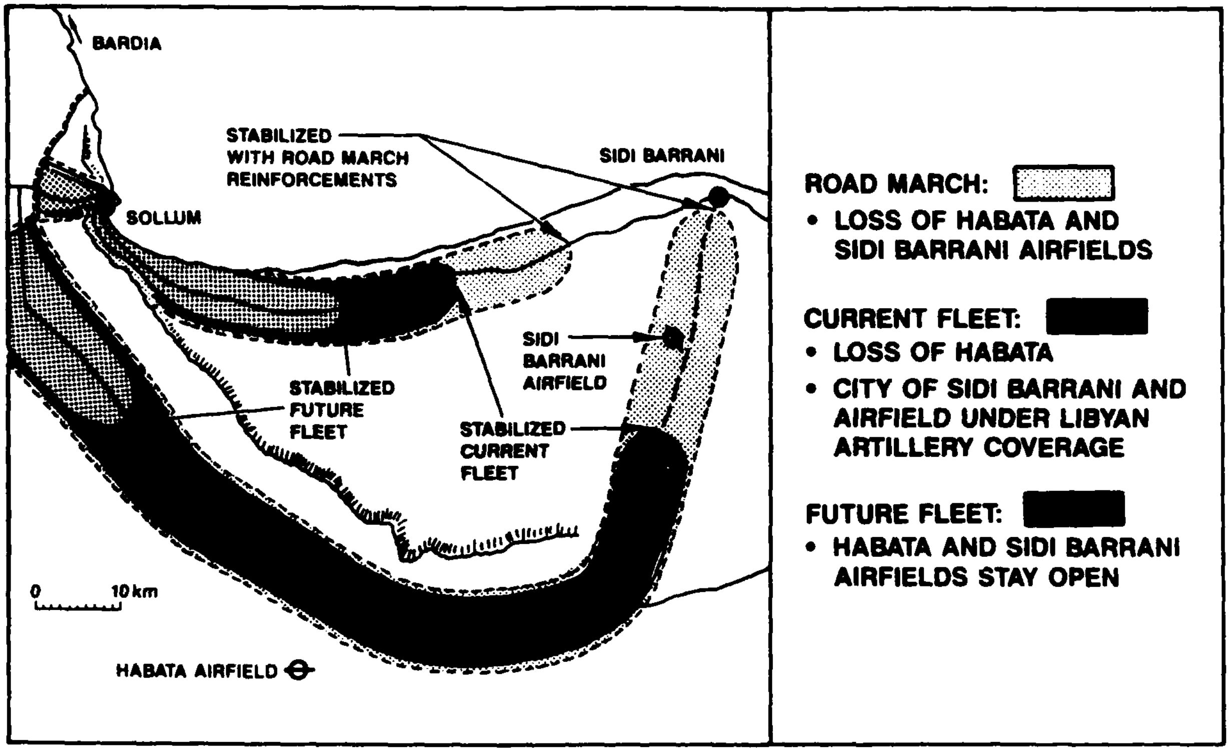



**Figure 14**

Habata remains free, and the Libyan invasion stalls out with heavy casualties, leaving them open to Egyptian counterattacks. This would lead to their quick annihilation, surrender and humiliation in the Arab and Third World countries.

Our analysis of airlift's impact on the battle outcome in a Korean scenario provides an additional example of how the methodology may be applied. To provide a measure of airlift effectiveness, an attack by the North Korean Army (NKA) across the DMZ into South Korea is simulated using CORPS TABS. The objective of the defending Republic of Korea (ROK) forces is to halt the NKA advance as close to the DMZ as possible while preparing to counterattack. For the purpose of the analysis, a ROK/U.S. Corps is left

uncommitted and held in reserve as a counterattack force. Therefore, reinforcement must come from other sources. Rapid delivery of the most effective firepower resources becomes a key to any decisive reinforcement plan. Accordingly, this study focuses on the impact of airlift on the posture for a ROK/U.S. counterattack after one week of combat.

Delivery rates of the same firepower by two different airlift fleets are considered. The current airlift fleet is contrasted to the future fleet with the C-17. The prime measure of effectiveness for the different airlift fleets is the depth of the North Korean penetration relative to Seoul and the North Korean battle losses in relation to territory gained. The scenario is depicted in Figure 15.

## SCENARIO – NKA ATTACKS ACROSS DMZ

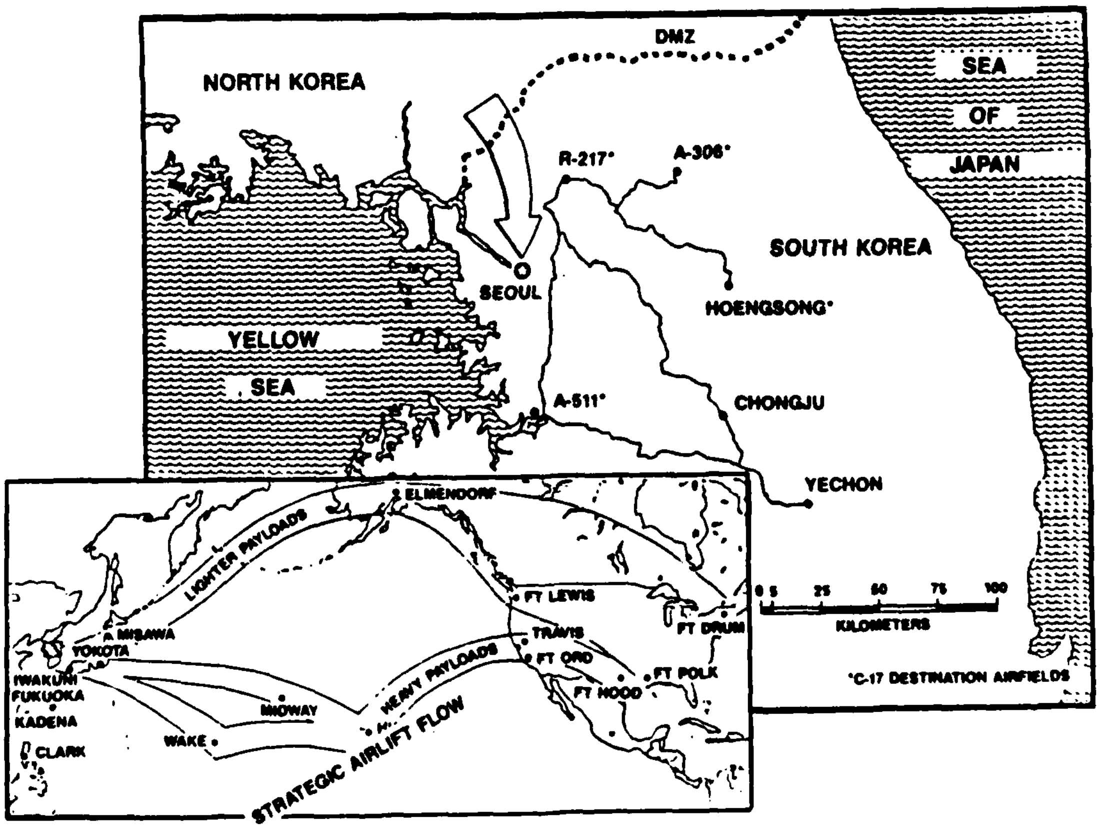



Figure 15

The airlift flow is shown in the inset to Figure 15. An extensive airlift analysis considered multiple on-load bases in the U.S., ramp and servicing restrictions at en route bases and aircraft capabilities. The result is summarized here. Air routes across the Pacific are selected to maximize the flow of firepower into Korea and to eliminate the need to refuel in Korea. Accordingly, two flight paths are used, each stopping in Japan prior to entering the war zone: a north-Pacific route stopping at Misawa AB, and a mid-Pacific route transiting Yokota AB. The northern route is the shortest and requires only one en route stop at Elmendorf AFB. However, the leg from Elmendorf to Misawa is over 3000 nautical miles and reduces the tonnage that can be carried. C-141s carrying the lighter helicopter loads can use this route to best advantage. The longer mid-Pacific route requires two en route stops. The C-17s and C-5s with heavy tank and armored vehicle loads use this route to maximize their payloads. Flights westbound from Hickam AFB stop at either Midway or Wake Island prior to Yokota. Nearly 84 percent of the unit tonnage is deployed using this route.

The mountainous terrain in the area of the DMZ must be examined to model a suitable attack route. The eastern section is extremely rugged, provides limited staging areas north of the DMZ and has narrow winding valleys that lead southwest passing Seoul to the east. The western section is more open, providing two short major lines of advance leading directly to Seoul. The western approach, the Kaesong-Munsan corridor, offers the shortest distance to Seoul, but the invaders first must cross the broad Imjin River. The other corridor is the Chorwon-Uijongbu corridor, which provides a direct route to Seoul channeled through relatively broad valleys and without major river crossings.

Both of these routes probably would be used for a North Korean attack; the Chorwon-Uijongbu corridor was chosen to model as a basis for our airlift analysis because it offers the fewest terrain obstacles to an attacker, making it the most likely avenue of approach for an armor force.

The channeling effect of the mountainous terrain is indicated in Figure 16. This figure also shows the level of detail that is included in the CORPS TABS data base. Trafficability and intervisibility both impact ground combat. These and related factors are included in the simulation to produce battle results.

## MOUNTAINOUS TERRAIN CHANNELS ATTACKS INTO CORRIDORS

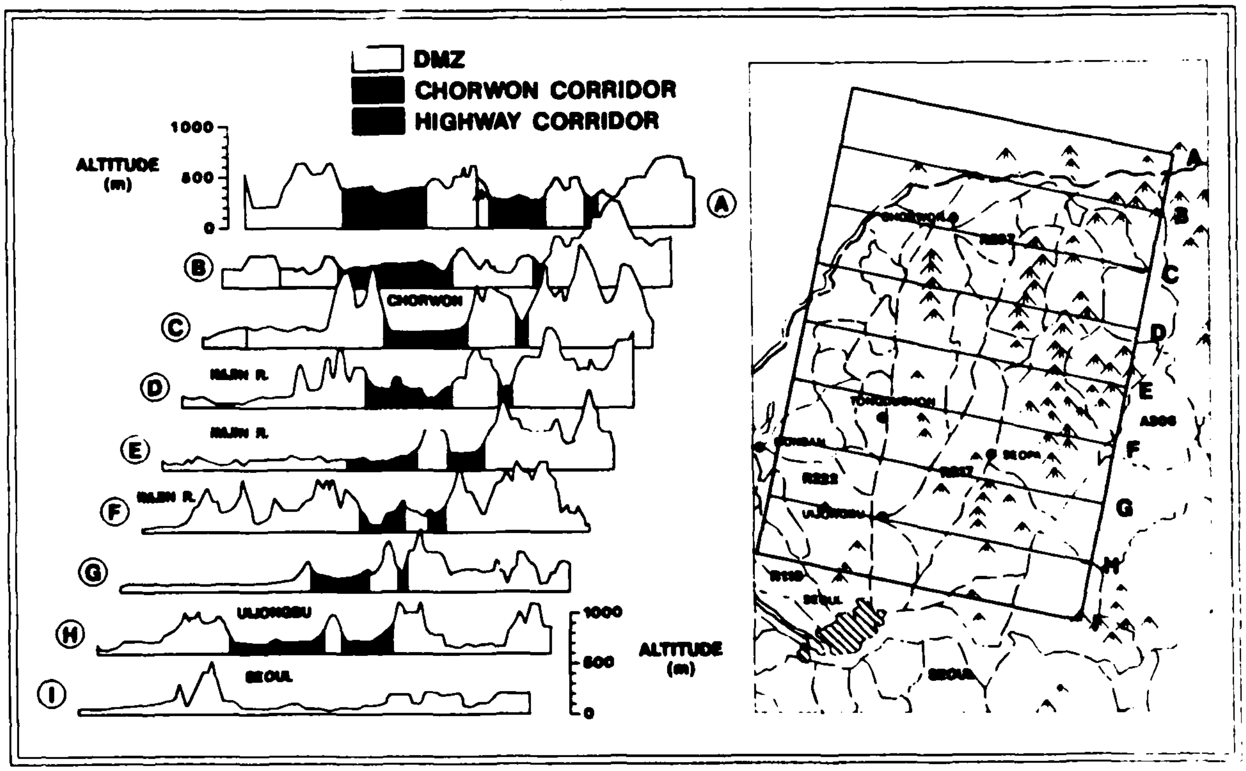



Figure 16

Figure 17 contrasts the reinforcement rates resulting from deployment by the two airlift fleets. The equipment silhouettes show the arrival of each unit in the battle area. Each symbol depicts a company, battery, or, in the case of the helicopter, a battalion size unit. The top half of the chart shows units that were deployed by the current fleet and the bottom half shows the same units when deployed by the future fleet.

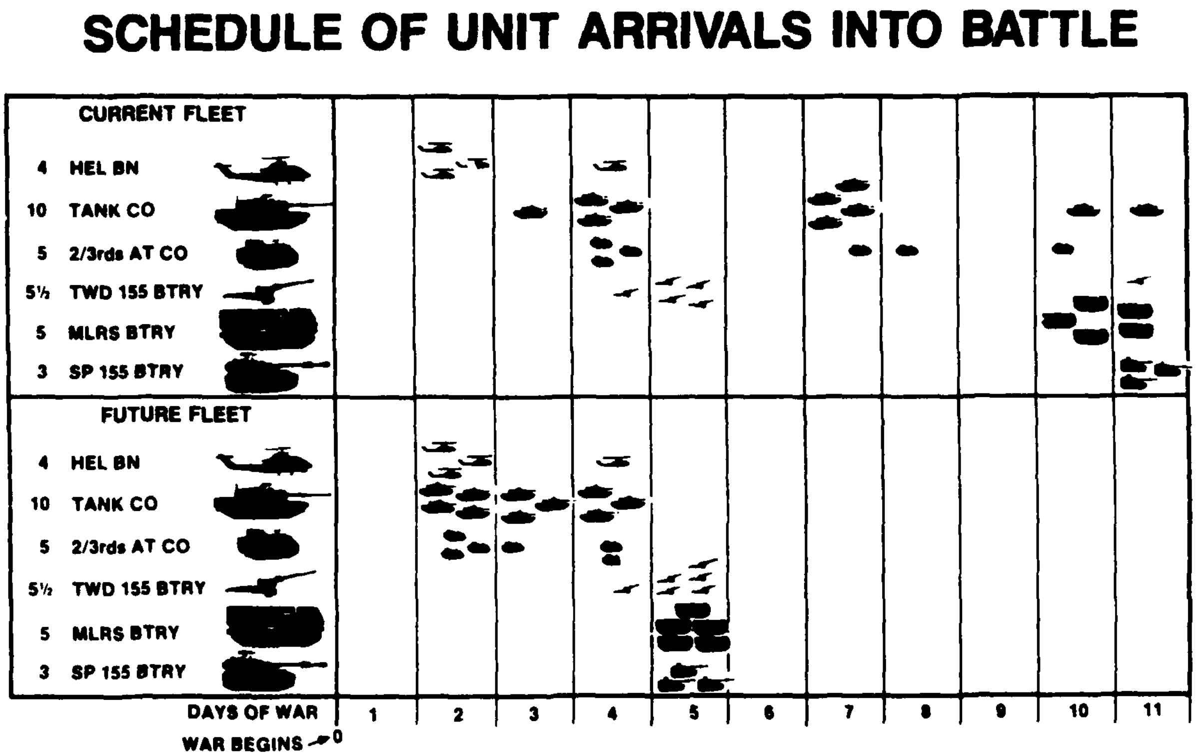



Figure 17

The future airlift fleet delivers the same units in less than one-half of the time required by the current fleet. Earlier delivery permits concentration of armor-killing firepower in the critical early days of the battle.

This significant reduction in unit closure is the result of a faster flow of men and equipment into offload airfields and the shorter road march to the battle area from the forward C-17 airfields. In addition, the airlift fleet is available for other commitments over five days sooner.

Figure 18 summarizes the results of the battle simulations and compares the two airlift cases. Although the simulations end after seven days of conflict, each reaches a critical point on day 6.

## COMPARISON OF BATTLE RESULTS

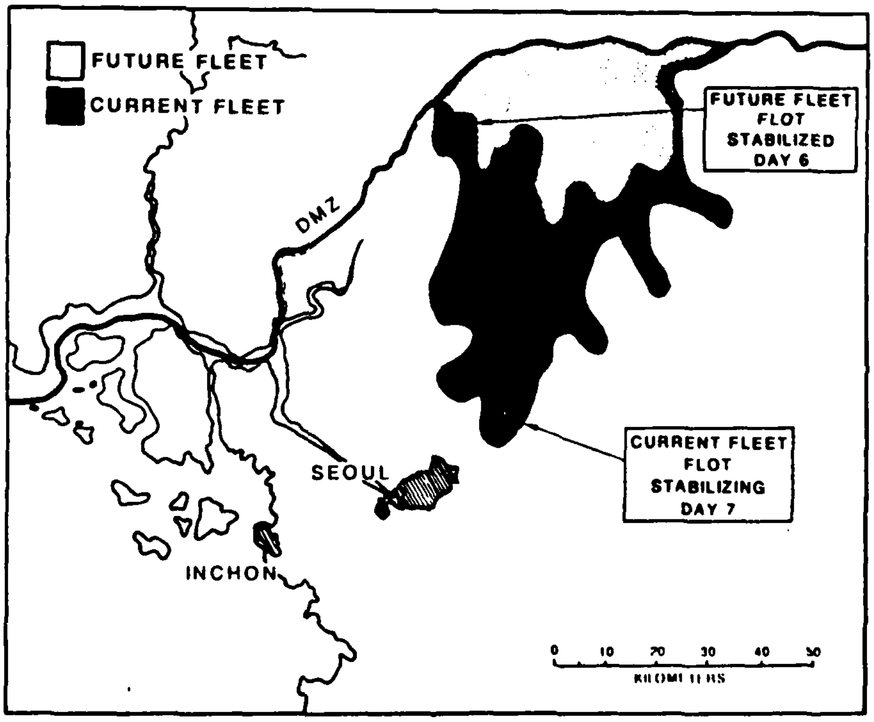



**Figure 18**

On day 6 in the current fleet case, enemy artillery has Seoul well within range. At the end of the simulation the force ratio still favors the NKA, but the forward line of troops (FLOT) is stabilizing and will not reach Seoul.

The impact of adding the C-17 to the future fleet is apparent as early as day 3. By day 5 the force ratio begins to favor the ROK, and on day 6 the

FLOT stabilizes 43 kilometers north of Seoul. This timely addition of firepower to the ROK force virtually stops the NKA invasion and preserves sufficient ROK forces to continue their defense and provide a posture for counterattack.

The depth of the NKA penetration is not the only form of CORPS TABS output. Key weapons systems destroyed during seven days of simulation are shown in Figure 19. Weapons systems are separated into three categories: artillery, rifle squads and armored fighting vehicles. NKA losses are depicted for each case by a white bar and corresponding ROK losses by the shaded bars. A dramatic increase in NKA losses and a gradual decrease in ROK losses occur as reinforcement arrivals increase to the future fleet level. The force exchange ratio increases from 1.6:1 to 1.8:1 in favor of the ROK. This is enough to shift the overall force advantage to the ROK by day 5.

## INCREASING AIRLIFT RAISES THE PRICE FOR ATTACKING THE ROK

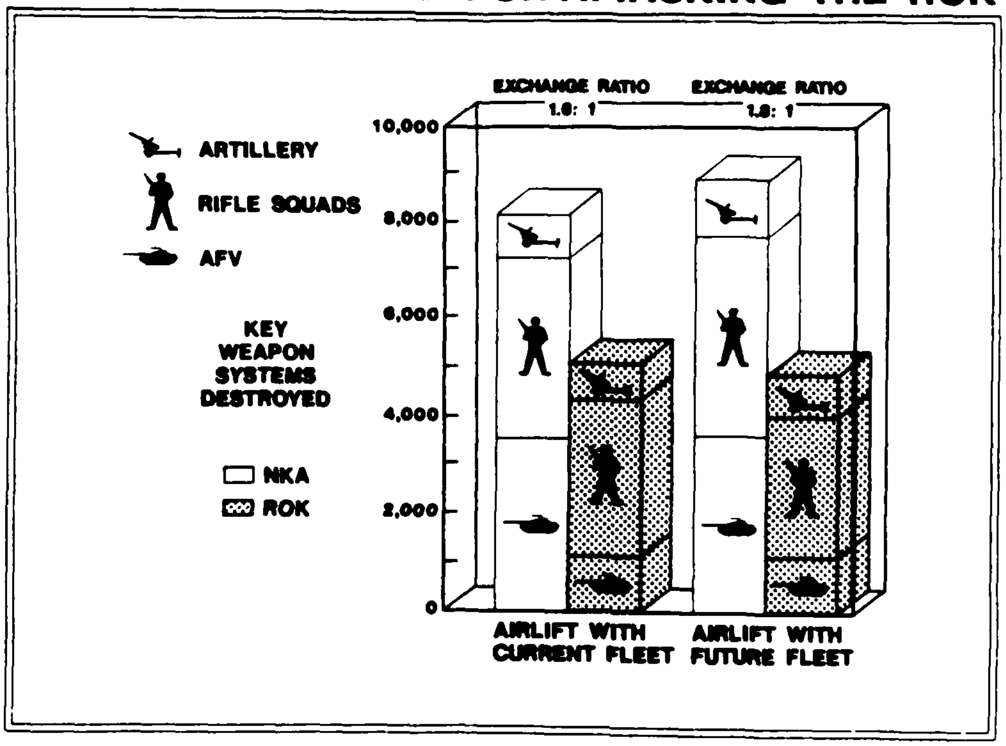



Figure 19

In this scenario, the modernized U.S. airlift fleet has a significant impact on the North Korean invasion. The NKA is contained near the DMZ and pays a heavy price for attacking South Korea.

We believe that this presentation has demonstrated a methodology that quantifies the impact of airlift on the success of combat operations. As noted in Figure 20, the method is adaptable to a variety of scenarios.

## AIRLIFT HAS AN IMPACT ON SUCCESS OF COMBAT OPERATIONS

- **Demonstrated a methodology**
- **Adaptable to variety of scenarios**
- **Quantified selected MOEs**

**Figure 20**

Examples were given for two different scenarios and recent studies have addressed three others. A variety of measures of effectiveness are available with the two combat simulation models. Progress has been made and demonstrated in the analysis of tactical transportation. Fortunately, challenges always remain. Annotated briefing reports of the two studies, C-17 Combat Utility Egypt/Libya and C-17 Combat Utility Study - Korea, cover the details of the analysis and interpretation of results in considerably more detail than available in this short presentation. Copies of the reports are available from the Mission Analysis Center, LTV Missiles and Electronics Group, P. O. Box 650003, M/S EM-76, Dallas, Texas 75265-0003.

Mr. Lyons has a wealth of experience, both in Government service and in private industry. He is a Naval Academy graduate commissioned into the Air Force. He has a Masters degree in Operations Research from Ohio State University. His 23 years of Air Force service ranged from tactical reconnaissance pilot to military operations analyst in Southeast Asia with the Joint Chiefs of Staff. He has also worked for the Nuclear Regulatory Commission, for Fairchild Republic Company, and for the past 9 years with LTV Aerospace and Defense Company where he is currently Engineering Project Manager for Air Warfare Mission Analysis.

Mr. Tiehen is an Aerospace Engineering graduate of Texas A&M University. While with LTV Aerospace and Defense Company for six years, he was a Lead Analyst with the Mission Analysis Group working on force effectiveness/benefit analysis for the MLRS and for the evaluation of airlift operations. He is currently working for Northrop Corporation on man-in-the loop studies using flight simulators.

CHAPTER 12

# USE OF VECTOR-3 CAMPAIGN MODEL FOR ANALYSIS OF TACTICAL TRANSPORT NEEDS

by Seth Bonder, PhD

ABSTRACT: This presentation describes the use of the VECTOR-3 campaign model to quantify tactical transport aircraft needs. Alternative airlift aircraft are played explicitly in VECTOR-3 to measure their impact on combat outcome. Military experts were used in a gaming process to develop scenarios for use in the simulation analysis. Simulation results are presented for two different scenarios. The results are summarized by observations and an identification of tactical airlifter needs.

## 12.0 PRESENTATION OUTLINE.

I - Background

II - Simulation Analysis Process

III - Results

IV - Observations and Needs

## 12.1 BACKGROUND.

This presentation represents study work conducted by Vector Research, Incorporated (VRI), in conjunction with and on behalf of Lockheed Corporation, to identify needs of an Advanced Tactical Transport (ATT) in order to focus development of airlifter technologies. Needs are defined as ATT capabilities that contribute significantly to combat effectiveness in support of AirLand Battle for the 1995-2015 time frame. The objectives of this study are presented in Figure 12-1.

An overview of the methodology employed in this study is shown in Figure 12-2. A task force comprised of retired general officers with extensive related experience contributed directly to the study effort in addition to providing guidance and review to study analysts throughout. Scenarios were developed for both Southwest Asia (SWASIA) and NATO. Alternative ATT configurations were used with the two scenarios in the AJAX war game to develop operational concepts, to understand the use of tactical airlifters within the scenarios, and to develop some A.I. based tactical decision rules for use in the VECTOR-3 campaign model.

IDENTIFY TACTICAL MOBILITY "NEEDS" IN SUPPORT OF AIRLAND BATTLE FOR THE 1995-2015 TIME FRAME

NEEDS ARE ADVANCED TACTICAL TRANSPORT (ATT) CAPABILITIES THAT CONTRIBUTE SIGNIFICANTLY TO CAMPAIGN EFFECTIVENESS

- SWASIA: DEFENSE OF KHUZISTAN OIL FIELDS (MIDEAST III SCENARIO)
- NATO: COUNTERATTACK AGAINST A SOVIET PENETRATION IN THE NORTHAG REGION OF AFCENT

RESULTS WILL BE USED TO FOCUS DEVELOPMENT OF AIRLIFTER TECHNOLOGIES

THE STUDY DOES NOT ADDRESS FLEET SIZE OR FLEET MIX ISSUES

Figure 12-1. Study Objectives.

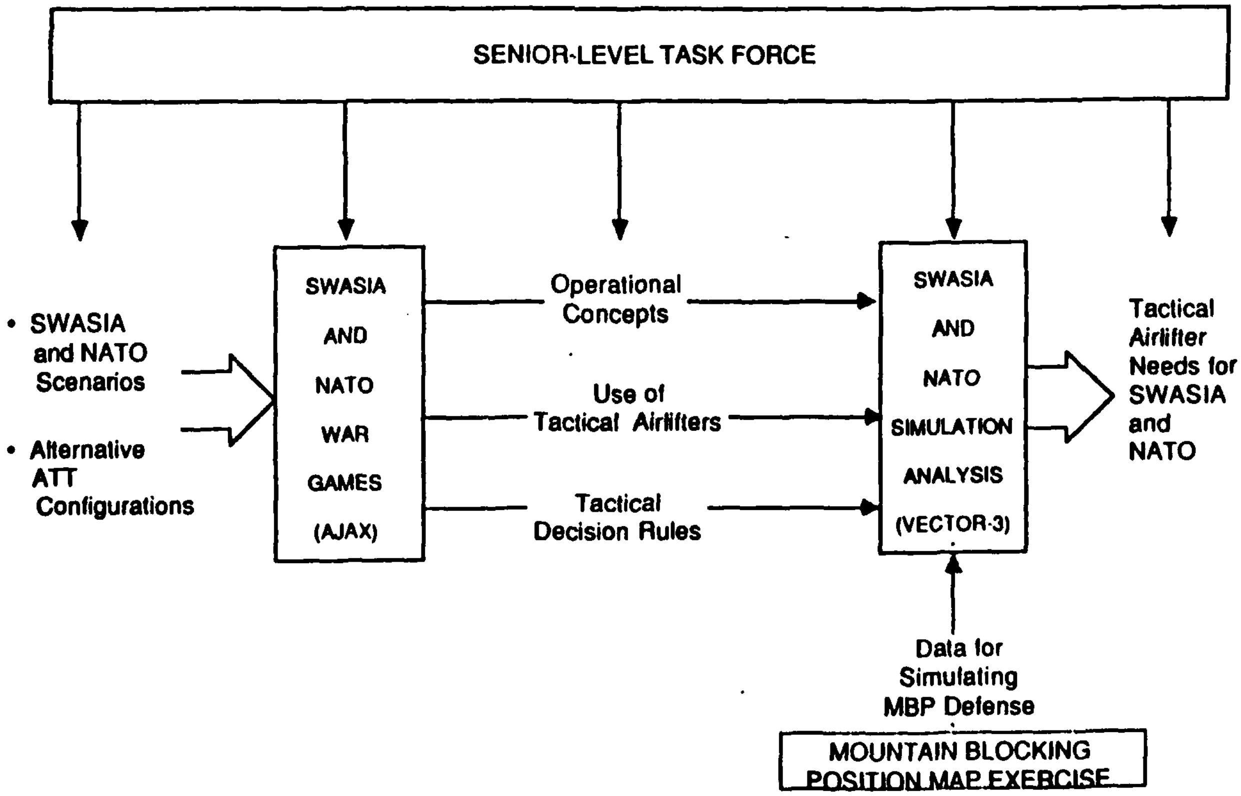



Figure 12-2. Study Methodology.

Together with data for simulating a mountain blocking position defense obtained from a map exercise, these operational concepts and rules were uded in the VECTOR-3 campaign model to conduct the simulation-based analysis of tactical airlifter needs for SWASIA and NATO. This presentation is concerned with only the simulation-based analysis which used the VECTOR-3 campaign model.

Figure 12-3 describes some of the characteristics of the VECTOR-3 campaign model as used in this study. It is used extensively by the military and defense industry for similar analyses.

REPRESENTS THE SPECTRUM OF ACTIVITIES AND PROCESSES INVOLVED IN A THEATER-LEVEL, TWO-SIDED, AIRLAND CAMPAIGN. THIRTY-SECOND TIME RESOLUTION FOR SOME ACTIVITIES

SCOPE: THEATER, ARMY GROUP, CORPS, OR DIVISION LEVEL

INCORPORATES MODULAR, DETAILED MODELS OF PHYSICAL AND BEHAVIORAL PROCESSES. EXPLICIT REPRESENTATION AND RESOLUTION TO INDIVIDUAL WEAPON/ITEM SYSTEM

AUTOMATED ARTIFICIAL INTELLIGENCE ("EXPERT SYSTEM") MODULES FOR RESOURCE ALLOCATION AND TACTICAL DECISION MAKING

GENERATES A DETAILED HISTORY OF THE CAMPAIGN

VECTOR-2 SUCCESSFULLY TESTED AGAINST RESULTS OF THE GOLAN HEIGHTS CAMPAIGN IN THE 1973 ARAB-ISRAELI WAR

USED BY TRADOC (TRASANA, CAC), STC, MICOM, JAD, CNA, DEFENSE INDUSTRY

VECTOR-3 IS ONE OF THE LATEST IN THE SERIES OF VECTOR MODELS. INCLUDES MORE DETAILED REPRESENTATION OF LOGISTICAL PROCESSES THROUGH EXPLICIT AIR AND GROUND TRANSPORT OPERATIONS AND A DETAILED GROUND TRANSPORTATION NETWORK.

Figure 12-3. The VECTOR-3 Campaign Model.

## 12.2 SIMULATION ANALYSIS PROCESS.

The first step in the simulation analysis process was to develop scenarios for both SWASIA and NATO. Figure 12-4 shows the locations, missions, and forces developed for these two scenarios. Note that the

| | SWASIA | NATO |
|---|---|---|
| LOCALE: | PERSIAN GULF | AFCENT REGION |
| MISSION: | DEFEND IN ZAGROS MOUNTAINS AGAINST SOVIET ATTACK | ATTACK TO PINCH OFF SOVIET PENETRATION IN NORTHAG |
| FORCES: | | |
| • LAND US: | 4 LIGHT + 1 HEAVY DIVISION | 6 HEAVY + 1 LIGHT DIVISION |
| SOVIET: | 15 HEAVY DIVISIONS | 17(-) HEAVY DIVISIONS |
| • AIR US: | 24 SQDNS TACTICAL AIRCRAFT | 65 SQDNS TACTICAL AIRCRAFT |
| SOVIET: | 46 SQDNS TACTICAL AIRCRAFT | 171 SQDNS TACTICAL AIRCRAFT |
| FORCE DENSITY: | ONE US DIVISION/ 48,000 $KM^2$ | ONE US DIVISION/ 8,000 $KM^2$ |
| GLOC: | POOR | GOOD |

Figure 12-4. Scenarios - Location and Forces.

| SYSTEM | SWASIA | | | NATO | | |
|---|---|---|---|---|---|---|
| | US | SOVIET | FORCE RATIO | US | SOVIET | FORCE RATIO |
| COMBAT VEHICLES | 1489 | 11033 | 7.4 | 3924 | 11027 | 2.8 |
| ARTILLERY TUBES/LAUNCHERS | 769 | 3096 | 4.03 | 960 | 4005 | 4.2 |
| TACTICAL AIRCRAFT | 560 | 728 | 1.3 | 1539 | 2744 | 1.8 |
| ATTACK HELICOPTERS | 350 | 256 | 0.73 | 378 | 262 | .70 |

Figure 12-5. Scenarios - Initial Weapon System Summary.

Ground Line Of Communication (GLOC) in SWASIA is poor which places increased importance on air transportation in that scenario.

Figure 12-5 lists the initial weapon system summaries for each force in the two scenarios. Notice the Soviet's 7.4 to 1 advantage in combat vehicles in SWASIA, and their strong advantage in artillery in both scenarios.

Figure 12-6 lists the campaign transportation assets available to the U.S. forces for each scenario. In addition to the base case of current assets, the forces were supplemented by the ATT forces shown in order to evaluate the contribution of an ATT. ATT considered included additional C-130H, a VTOL airlifter, an advanced cargo rotorcraft (ACR), a large strategic airlifter (LSAL), and a STOL airlifter.

Figure 12-7 lists four categories of special ammunitions or ordnances required by U.S. forces in the NATO scenario. These munitions represent a very high priority resupply requirement because of their significant

| BASE: | | SWASIA | NATO |
|---|---|---|---|
| • TRUCKS: | | 3298 | 5160 |
| • UH-60A: | CORPS CONTROL | 90 | 120 |
| • CH-47D: | CORPS CONTROL | 96 | 96 |
| | | 186 | 216 ARMY AIRLIFTERS |
| • C-130H: | ALCC CONTROL | 144 (3 WINGS) | 112 (7 SQDNS) |
| SUPPLEMENT: | | | |
| • ATT: | ALCC CONTROL | 96 (2 WINGS) | 80 (5 SQDNS) |
| | | 240 | 192 AF AIRLIFTERS |
| | | 426 | 408 TOTAL AIRLIFTERS |

Figure 12-6. Scenarios - Campaign Transportation Assets.

| 5S1 | 5S2 | 5AS1 | 5AS2 |
|---|---|---|---|
| AAWSM | 120MM APDS | AIM-120 (AMRAAM) | AIM-9 (SIDEWINDER) |
| LRAT | TOW-II | AGM-65D (IR MAVERICK) | GBU-15 |
| GAMP | HELLFIRE | AGM-88 (HARM) | |
| COPPERHEAD II | STINGER MSL | | |
| SADARM | CHAPARRAL MSL | | |
| MLRS TGW | 155MM RAP | | |
| ATACMS TGW | 8IN RAP | | |
| PATRIOT MSL | ROLAND/RAPIER MSL | | |
| | I-HAWK MSL | | |

Figure 12-7. NATO Scenario Special Ammunition/Ordnance.

contribution to the battle outcome. A special "federal express" supply process was used in the simulated campaign for these classes of supplies.

Finally Figure 12-8 summarizes major policy differences for U.S. forces between the two scenarios. These differences have an impact on theater transportation requirements.

Figure 12-9 identifies the major components of the study as detailed in the VECTOR-3 model. The extensive database includes the many component details necessary to describe intratheater transportation and the detailed characteristics of combat and combat support assets for the opposing forces. The transportation system, thus described, is composed of resources with specific capabilities and a description of resupply and movement missions which those resources will attempt to accomplish.

The delivery activity is added to the campaign processes which incorporate the interactions of combat and combat support systems with $C^3I$, supportability, and environmental factors to resolve combat engagements. These campaign results are collected at the macro or

| SWASIA | NATO |
|---|---|
| • INTRATHEATER SUPPLY OF ALL AIR FORCE AMMUNITION TO AIR BASES | • STRATEGIC DELIVERY OF AIR FORCE SPECIAL AMMUNITION DIRECT FROM CONUS TO OPERATING AIR BASES |
| • STANDARD AIR FORCE AERIEL PORT ELEMENT (APE) DEPLOYMENT PACKAGE AVAILABLE AT AIRFIELDS | • ADEQUATE AERIEL PORT ELEMENT (APE) RESOURCES ALWAYS AVAILABLE AT AIRFIELDS |
| • NORMAL SUPPLY STOCKAGE AT ALL ECHELONS | • NON STOCKAGE OF SPECIAL AMMUNITION AT INTERMEDIATE SUPPLY LEVELS |
| • TERMINAL PICKUP ALLOWED FOR CH-47D AND UH-60A | • TERMINAL PICKUP FOR CH-47D AND UH-60A PROHIBITED |

Figure 12-8. Scenarios - Policy Differences.

aggregated statistics level in terms such as FLOT movement, combat vehicle losses and attributions, tactical aircraft losses and attributions, etc., and in micro or detailed time histories level in terms such as detections, weapon firings, attacks on specific targets, and results of specific engagements. Consumption of key items of munitions, POL, and weapon systems are also recorded in the campaign process. These consumption factors in turn generate a demand on the intratheater transportation system.

The ability of the transportation system to supply and move units in response to the generated demand is then measured as a key variable in the simulation of the campaign process in VECTOR-3. The analysis then examines the contribution such intratheater transportation activities, and the capabilities of the airlifters that performed them, have on the campaign results. The airlifter capabilities that appear to contribute significantly to campaign effectiveness are thus identified as tactical aircraft "needs".

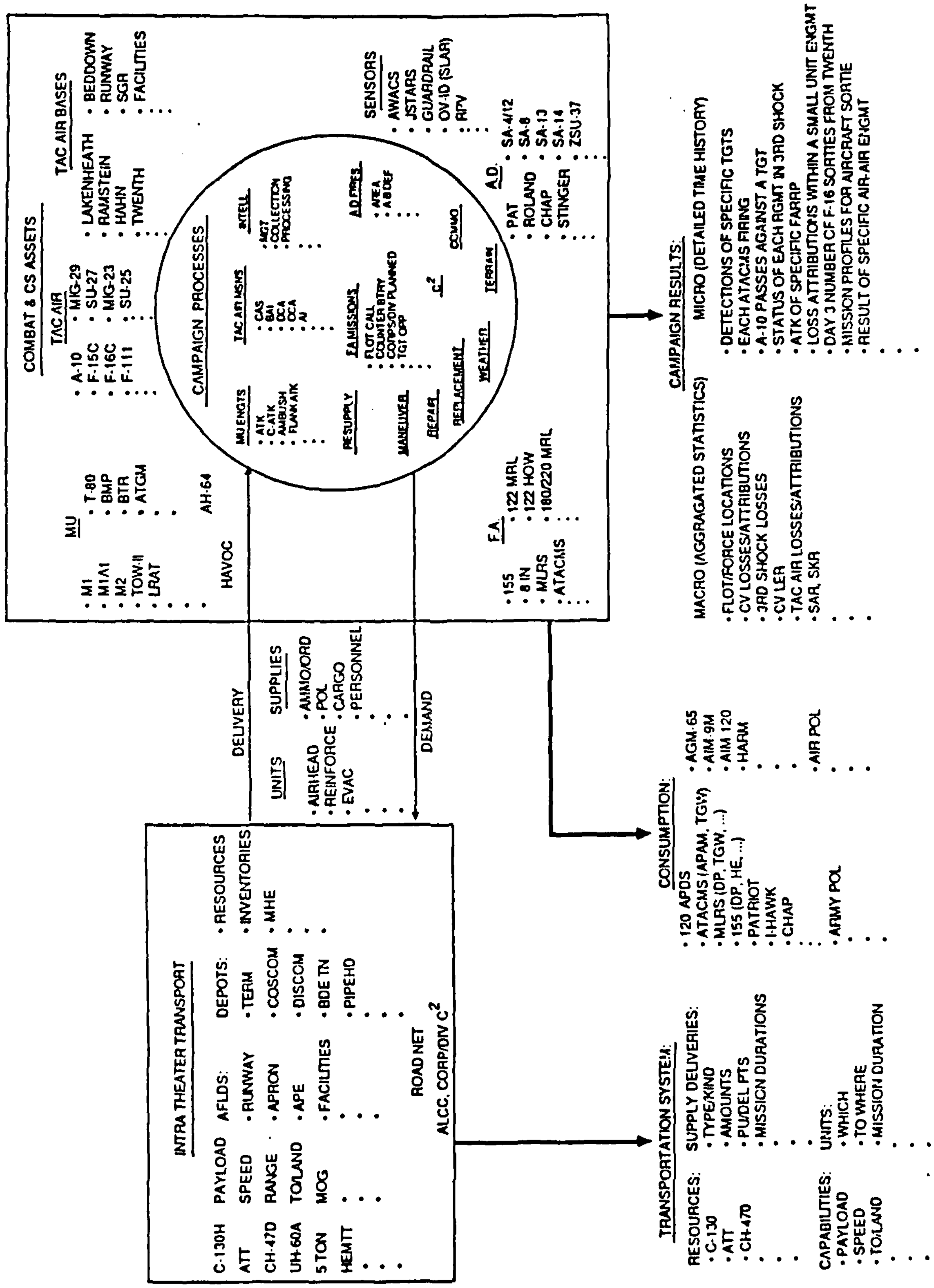



Figure 12-9. Simulation Analysis Process.

## 12.3 RESULTS.

The difference in campaign and transportation activities between the two scenarios is summarized in the description of scenario results in Figure 12-10.

The SWASIA scenario is characterized by relatively small unit defensive operations to delay and congest opposing forces. There is a low average intensity of direct fire combat and a large number of airlift unit moves. The average tonnage moved by an ATT is relatively small (19 short tons per day), but the average sortie distance is relatively long (200 nautical miles). The responsiveness of delivery by airlift was more important in this scenario than the amount of supplies delivered.

By contrast, the NATO scenario is characterized by brigade-sized forces conducting offensive or counterattack operations. Here the emphasis is on deep attack of follow-on forces with fires to support large and very intense maneuver unit engagements. There are relatively few airlift unit moves with the primary emphasis on resupply of Army forces. The average tonnage moved by an ATT is relatively large (57 short tons per day) with a more moderate average sortie distance (143 nautical miles). Both the responsiveness of airlift delivery and delivery of large amounts of supplies was important in this scenario.

| SWASIA | NATO |
|---|---|
| • US COMPANY-BN SIZED FORCES CONDUCT MOUNTAIN BLOCKING POSITION AMBUSH DEFENSES TO DELAY AND CONGEST SOVIET FORCES | • US BRIGADE-SIZED FORCES CONDUCT FLANK ATTACKS TO SEIZE OBJECTIVES IN PENETRATION AREA |
| • HEAVY TAC AIR AND ARTILLERY FIRE SUPPORT ACTIVITIES TO ATTRIT SOVIET FORCES AT MOUNTAIN BLOCKING POSITIONS | • TAC AIR AND ARTILLERY FIRE SUPPORT OF THE FLANK ATTACKS AND INTERDICTION/ DEEP ATTACK OF FOLLOW-ON FORCES |
| • LONG REINFORCEMENT DISTANCES | • SHORT REINFORCEMENT DISTANCES |
| • LOW AVERAGE INTENSITY OF DIRECT FIRE COMBAT | • LARGE AND VERY INTENSE MANEUVER UNIT ENGAGEMENTS |
| • LARGE NUMBER OF AIRLIFT UNIT MOVES FOR REINFORCEMENT | • SMALL NUMBER OF AIRLIFT UNIT MOVES EXCEPT FOR AIRHEAD OPERATION |
| • RESUPPLY OF ARMY FORCES AND AIR FORCE BASES | • PRIMARILY RESUPPLY OF ARMY FORCES |
| • SMALLER TONNAGES: (19 ST/VTOL/DAY) (APPROXIMATELY 65-75 PERCENT BY TRUCK) | • LARGER TONNAGES: (57 ST/VTOL/DAY) (APPROXIMATELY 65-70 PERCENT BY TRUCK) |
| • 200 NM AVERAGE SORTIE DISTANCE | • 143 NM AVERAGE SORTIE DISTANCE |
| • FOCUS ON COSCOM TO DISCOM MISSIONS. COSCOM OPERATED TERMINALS | • FOCUS ON TERMINAL TO DISCOM/BDE MISSIONS. THEATER ARMY OPERATED TERMINALS; DIMINISHED COSCOM ROLE |
| • RESPONSIVENESS MORE IMPORTANT THAN AMOUNT OF SUPPLIES DELIVERED | • REQUIREMENT FOR RESPONSIVENESS AND DELIVERY OF LARGE AMOUNT OF SUPPLIES |

Figure 12-10. Results - Nature Of Campaign And Transportation Activities.

SWASIA results are shown in Figures 12-11 through 12-17. Figure 12-11 shows the synergism of adding a vertical takeoff and landing (VTOL) ATT to the tactical airlift fleet of C-130H and Army helicopters. All elements of the fleet produce more payload[1] sorties with this combination than with any other combination. Figure 12-12 shows the increased productivity of the VTOL ATT fleet is particularly evident in movements from terminals to the air bases, from Corps Support Command (COSCOM) to Division Support Command (DISCOM), and from DISCOM to Brigade Trains. Because of the efficiency of these moves, less sorties are flown directly from COSCOM to Brigade Trains areas. Figure 12-13 shows the VTOL ATT fleet moves essentially the same total tonnage as the fleet containing the LSAL.

Figures 12-14 and 12-15 show the impact of an ATT on the required number of airlifted unit moves. The differences in number of airlifted unit moves among the ATT are small: the no-ATT case (C-130H bar) required the most moves while the VTOL and STOL ATTs (together with the ACR) required the same number as the theoretically ideal airlifter (TSTD bar). The time to complete an airlifted unit move varied significantly among the ATT. The VTOL ATT fleet's times required for these unit moves was less than all except the theoretical best (TSTD case). The ability of an ATT to perform an airlifted unit move responsively is significantly move important to campaign results than the number of such moves made by an ATT.

The impact of these airlifter fleet activity differences are shown in Figures 12-16 and 12-17. The VTOL ATT fleet produces the most favorable Soviet/U.S. force ratio over time and results in a longer period of time the U.S. forces are able to hold the mountain barrier before penetration by Soviet forces.

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[1] A payload sortie is in contrast to those in which an aircraft departs a takeoff location without a payload, e.g., departs a delivery destination point to return to a pickup point or to its beddown location.

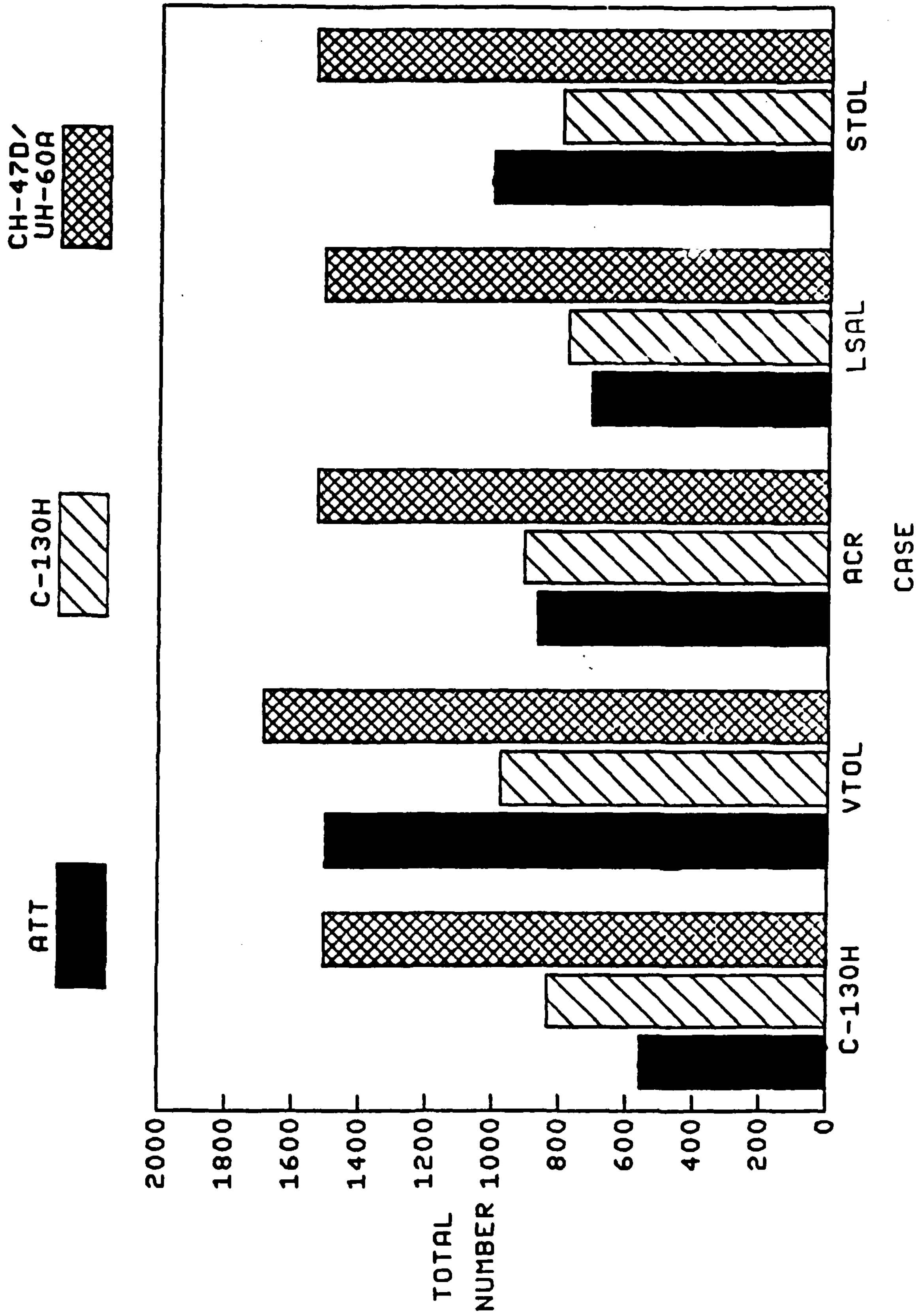


Figure 12-11. SWASIA - Number of P-Sorties.

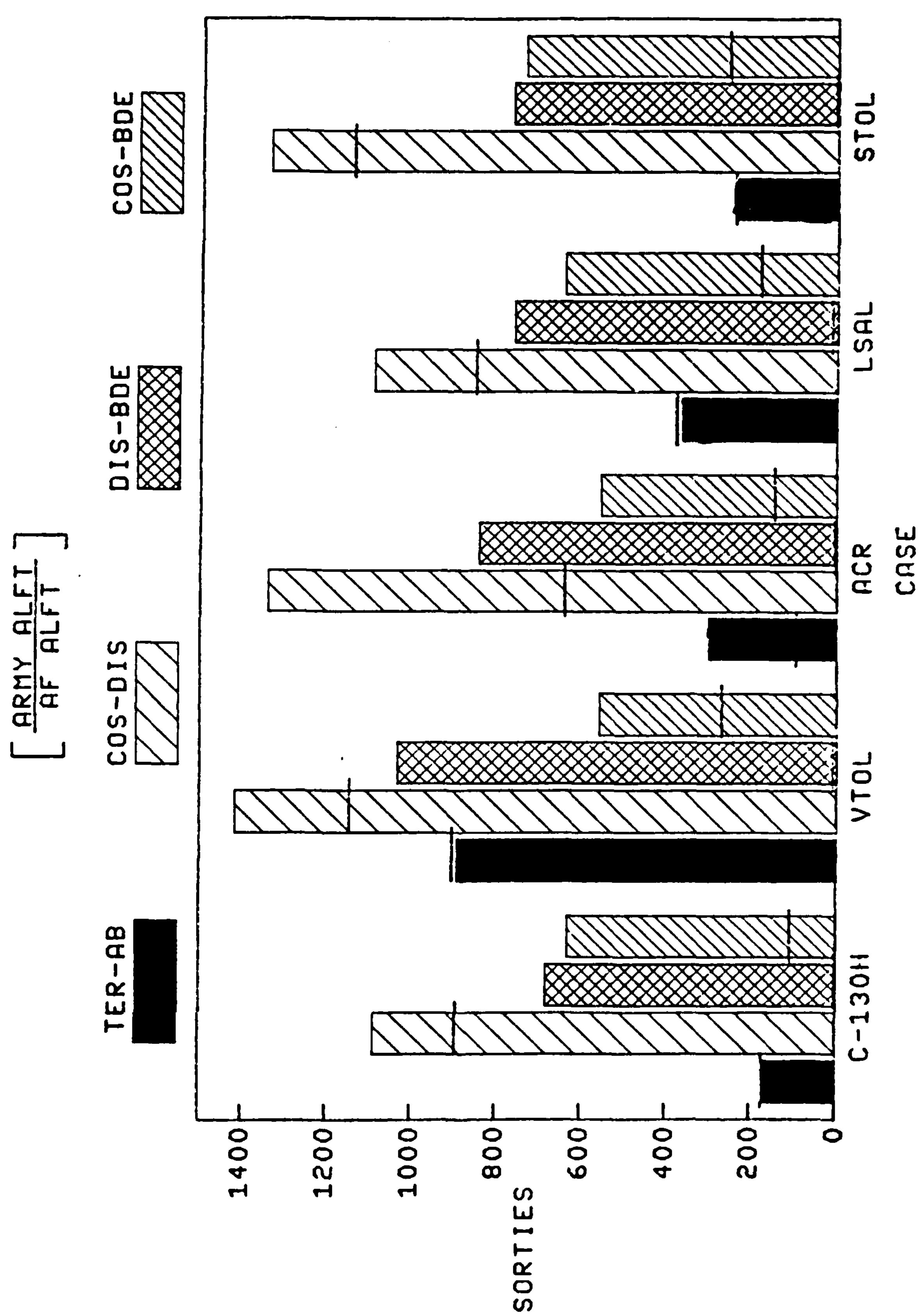


Figure 12-12. SWASIA - P-Sortie Distribution.

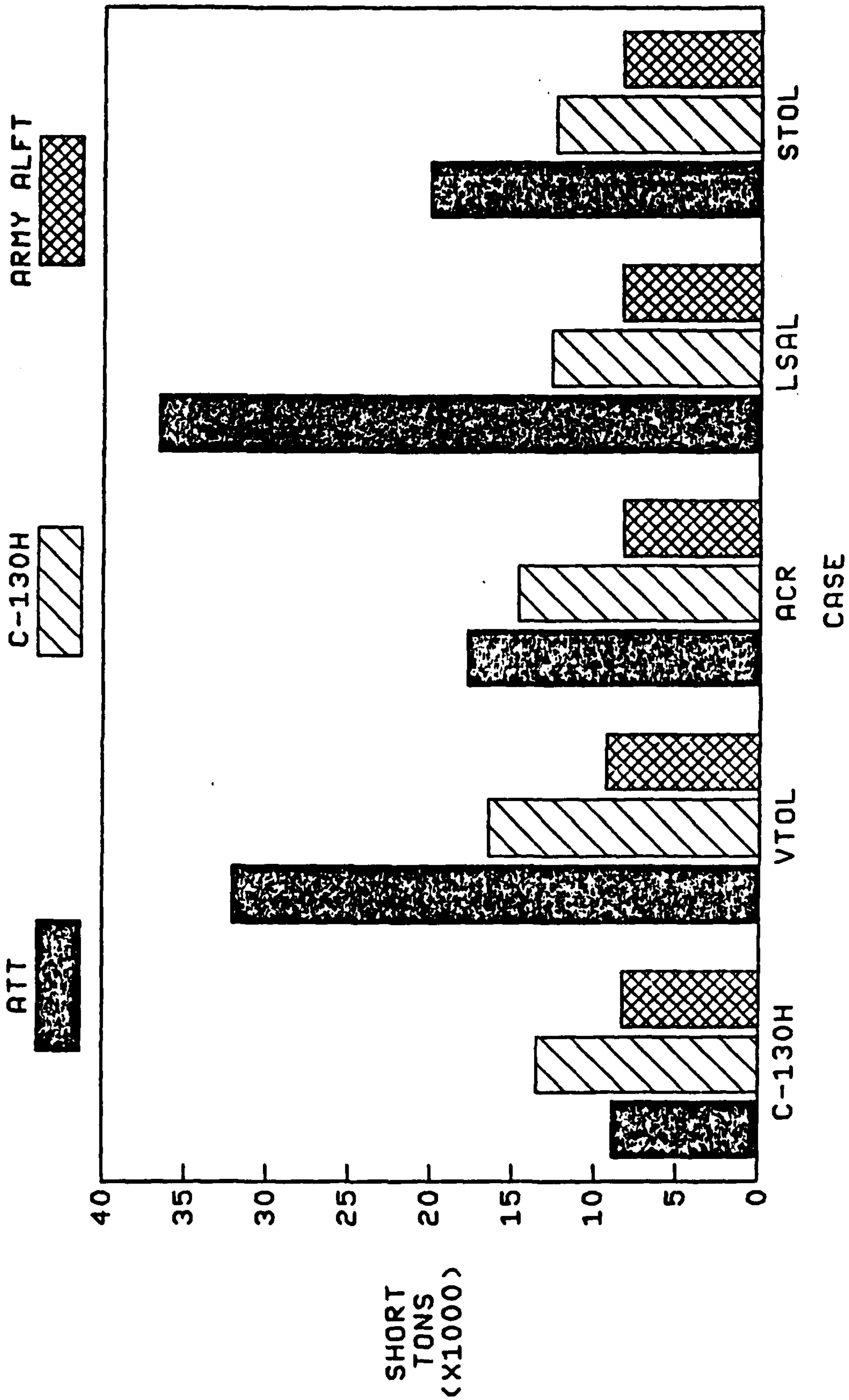


Figure 12-13. SWASIA - Total Airlifted Payload.

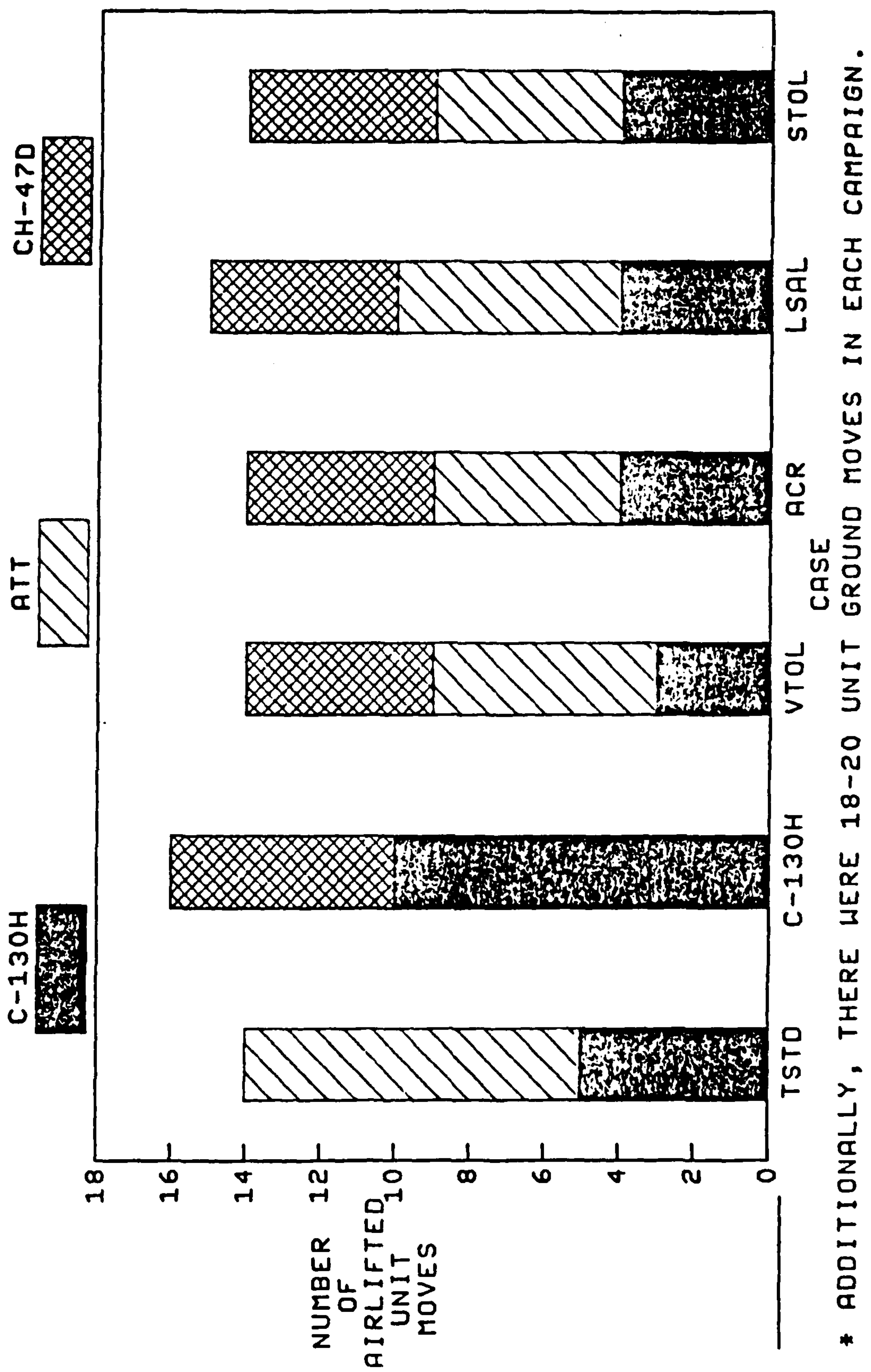


Figure 12-14. SWASIA - Number Of Explicit Airlifted Unit Moves.

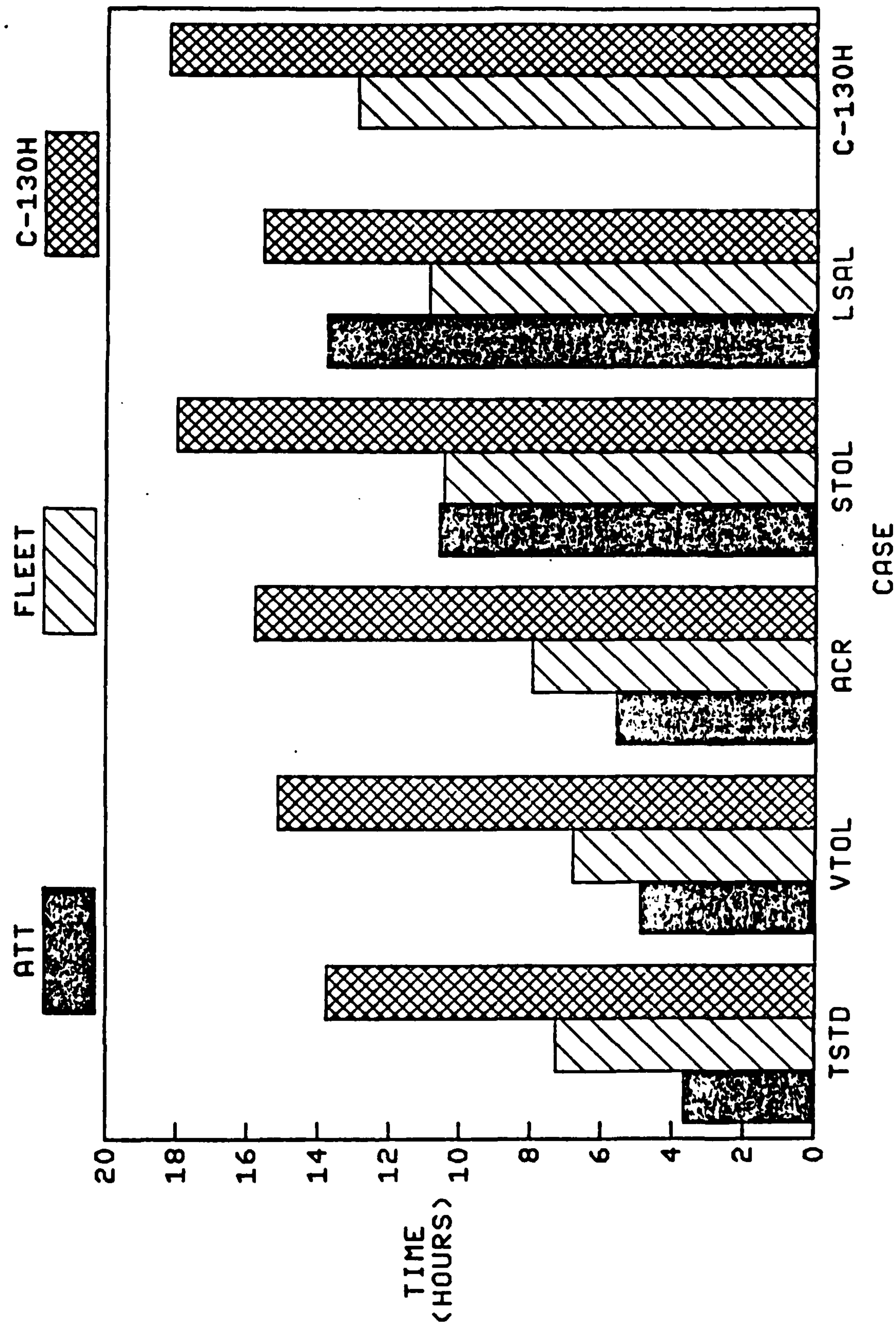


Figure 12-15. SWASIA - Average Time For Airlifted Unit Move.

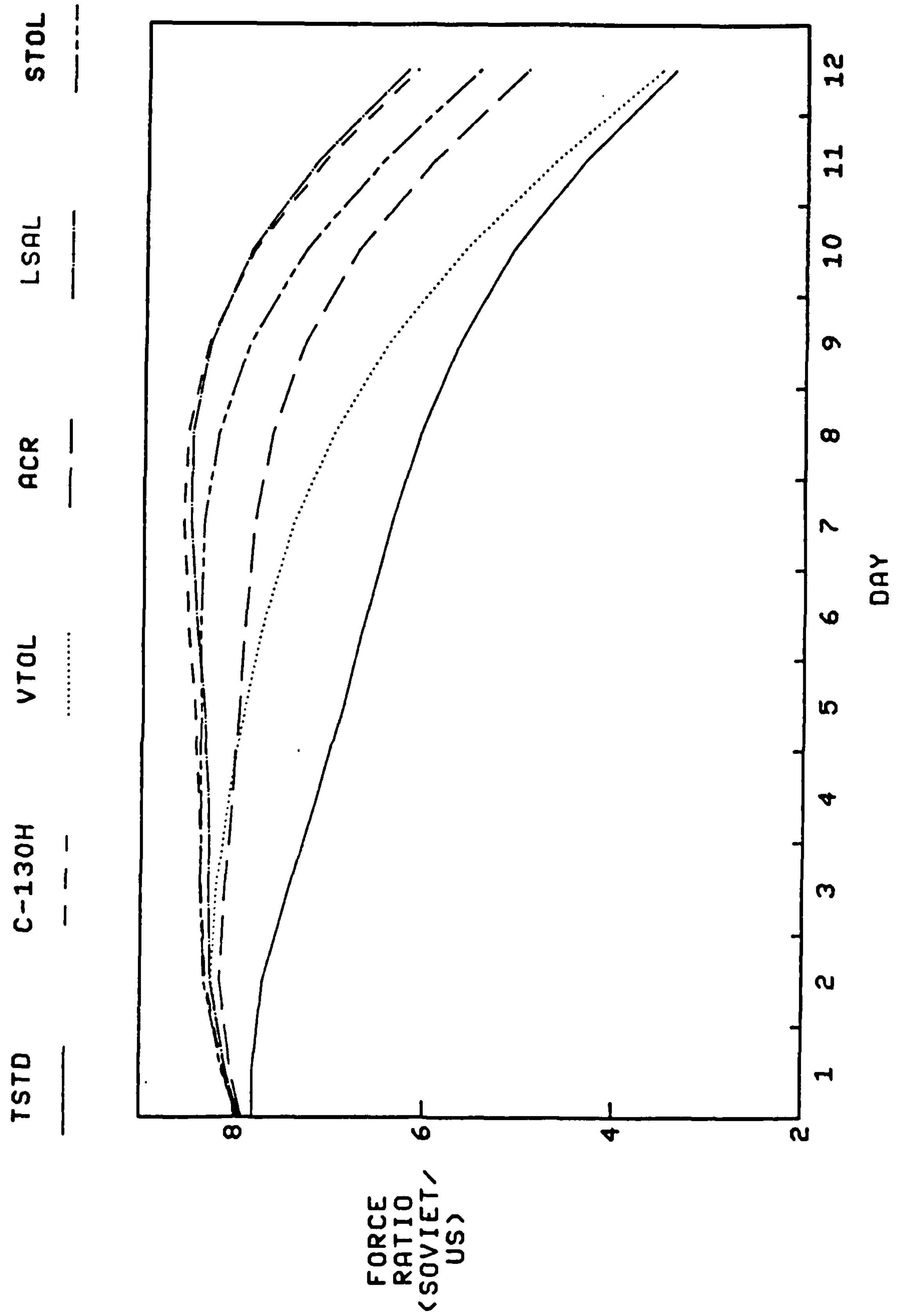


Figure 12-16. SWASIA - Smoothed Projection of Combat Vehicle Force Ratio.

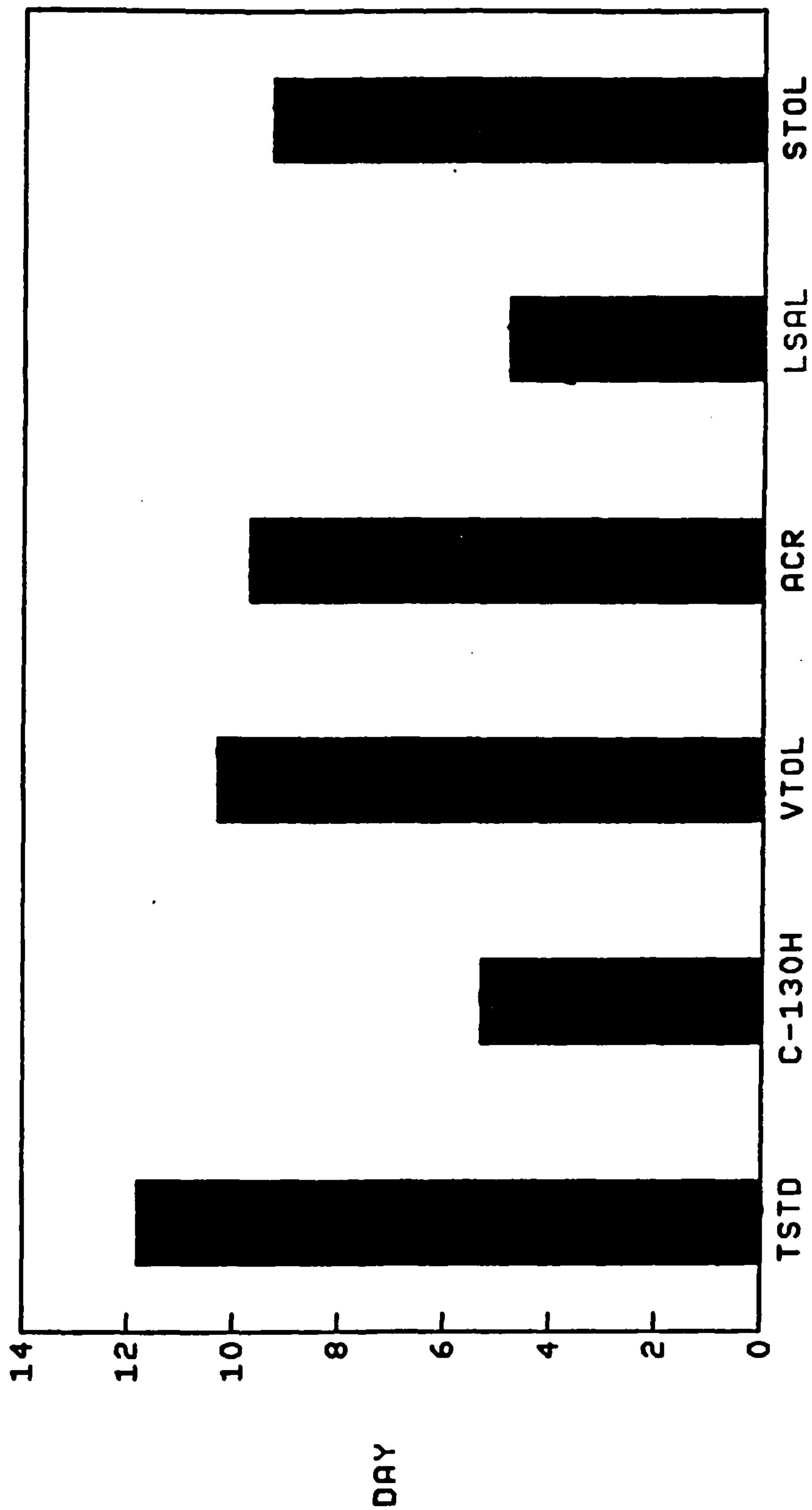


Figure 12-17. SWASIA - Projected Min Time Until Mountain Barrier Penetration.

NATO results are shown in Figures 12-18 through 12-33. Figure 12-18 shows the impact on payload sorties from the addition of various ATT alternatives. Both the VTOL and STOL (short takeoff and landing) ATTs perform more payload sorties, although the VTOL ATT fleet requires less sorties from the CH-47D/UH-60A helicopters. Figures 12-19 and 12-20 provide information regarding the distribution of pickup and delivery type locations for each of the ATT in the simulated campaigns. Figure 12-21 shows the dominance of an airlifter fleet with the large airlifter (LSAL) in terms of total tonnage delivered. The VTOL ATT delivers more total tonnage than the STOL ATT.

Figure 12-22, showing a comparative FLOT history for the 4th Mechanized Division (MD) in the simulated NATO campaign, illustrates the value of the theoretically ideal airlifter (TSTD) in supporting combat operations. The VTOL ATT does contribute better to combat results than any alternative. Figures 12-23 and -24 show the effect of various airlifter alternatives on the relative force ratios involved in the combat. The VTOL ATT contributes to the best (i.e., smallest) force ratio although the STOL and LSAL cases are not significantly worse. The no Air Force airlifter case (NAL) clearly led to the worst (i.e., largest) force ratios. In a similar vein, Figure 12-25 presents the loss exchange ratios (LER), which are a ratio of Soviet losses to U.S. losses, for the airlifter alternatives. In this case, the largest LER is best and the VTOL case is clearly best (after the theoretically ideal case). Again the NAL case is clearly worst.

One of the questions raised by some members of the Task Force was, "What is the value of Air Force airlifters to the campaign?" The NAL case, which removed all C-130H and ATT from the intratheater airlifter fleet, was introduced for this purpose. It is clear from the campaign results presented so far that the ATT cases lead to significantly better campaign results (FLOT locations, surviving force ratios, LER, etc.) than the NAL case. The LER provides an easy means of computing an Air Force airlifter "value" measure for the different ATT cases. The measure, displayed in Figure 12-26, is "the percentage savings in U.S. combat vehicle losses over the NAL case for a fixed level of Soviet combat vehicle losses." From the figure we observe that the VTOL savings in

combat vehicles is 24 percent over the NAL case. Thus, to obtain the approximate 6,500 Soviet combat vehicle losses obtained by the NAL case, the VTOL case would lose 624 less U.S. combat vehicles (tanks, IFV, CFV) than the 2,600 lost in the NAL case.[2] The C-130H would conserve 286 U.S. combat vehicles in defeating the same threat. Additional "value of airlifters" also accrues through savings in tactical aircraft.

Figure 12-27 shows total combat vehicle losses of Soviet 2d echelon forces prior to their commitment to front line combat. The VTOL and LSAL forces have the best impact because of their ability to provide ATACMS (Army Tactical Missile System) munitions (Figure 12-28 shows the effect of ATACMS attack on Soviet follow-on forces for the C-130H case). Another way to illustrate the impact of the various airlifter alternatives on the attack of follow-on forces is shown in Figure 12-29, which plots the cumulative combat vehicle losses over time of the 3rd Soviet Army (prior to commitment to direct fire combat). The effect of these losses of the 3rd Soviet Army is shown in Figure 12-30, which plots the arrival of that organization's combat vehicles at the front line over time. It shows the effect of deep attack on metering the arrivals to the FLOT for servicing by the front line defensive forces.

Figure 12-31 shows the correlation between Soviet combat vehicle losses and the consumption of U.S. Army special ammunition. More special ammunition is consumed in the VTOL case which resulted in a higher degree of combat effectiveness, as measured by Soviet losses. Similarly, Figure 12-32 shows the correlation of overall combat vehicle LER with U.S. Army special ammunition consumed. Finally, Figure 12-33 plots the correlation of the depth of the Soviet counterattack penetration in the U.S. III Corps sector with the combat vehicle LER in the III Corps sector. This exhibit, coupled with the previous one, suggests that campaign effectiveness, as measured by the ability to reduce Soviet penetration of the defensive positions, is also correlated with the amount of special ammunition consumed.

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[2] This is more than the number of combat vehicles in an average U.S. armored or mechanized infantry division.

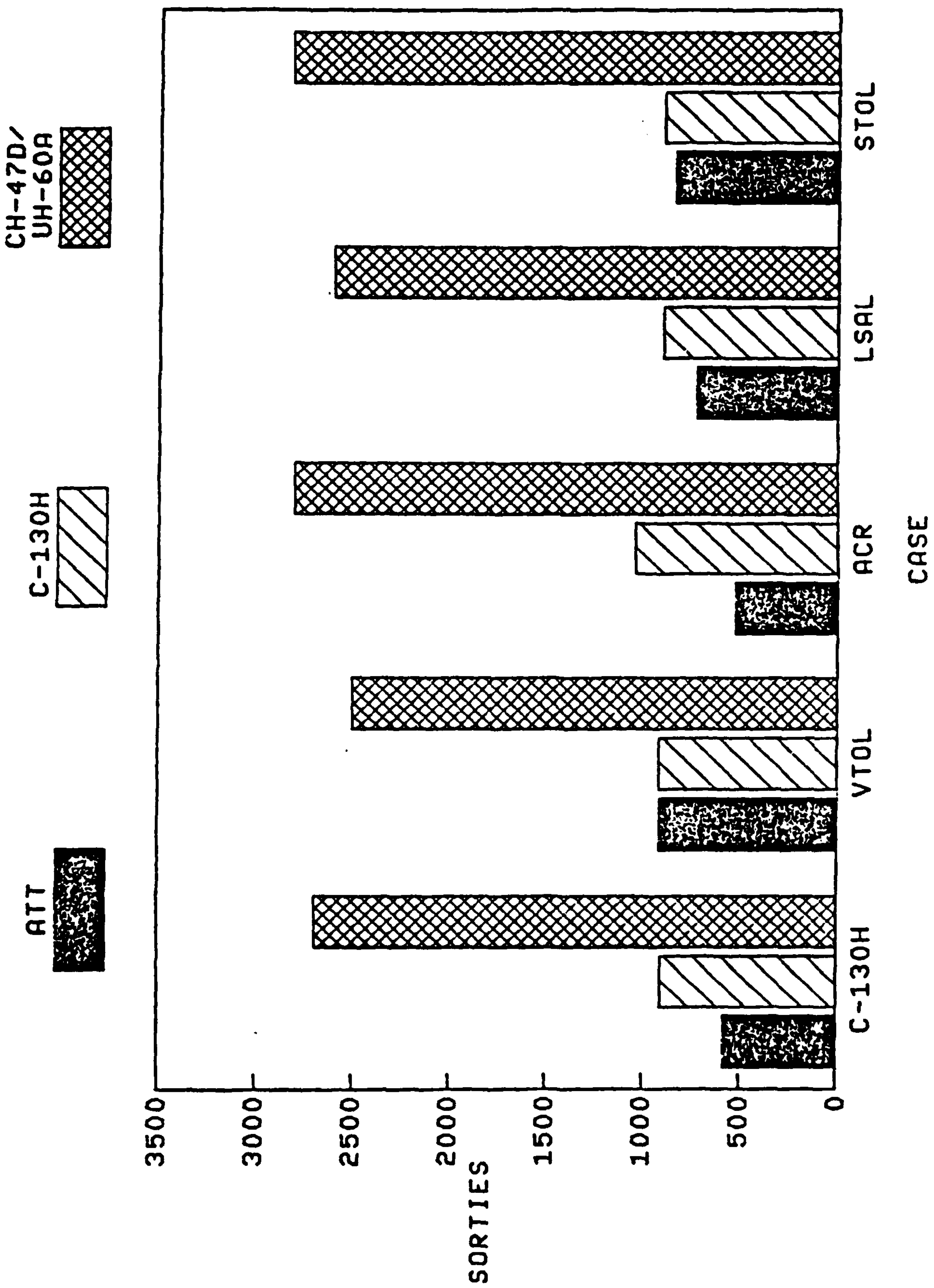


Figure 12-18. NATO - Number of P-Sorties.

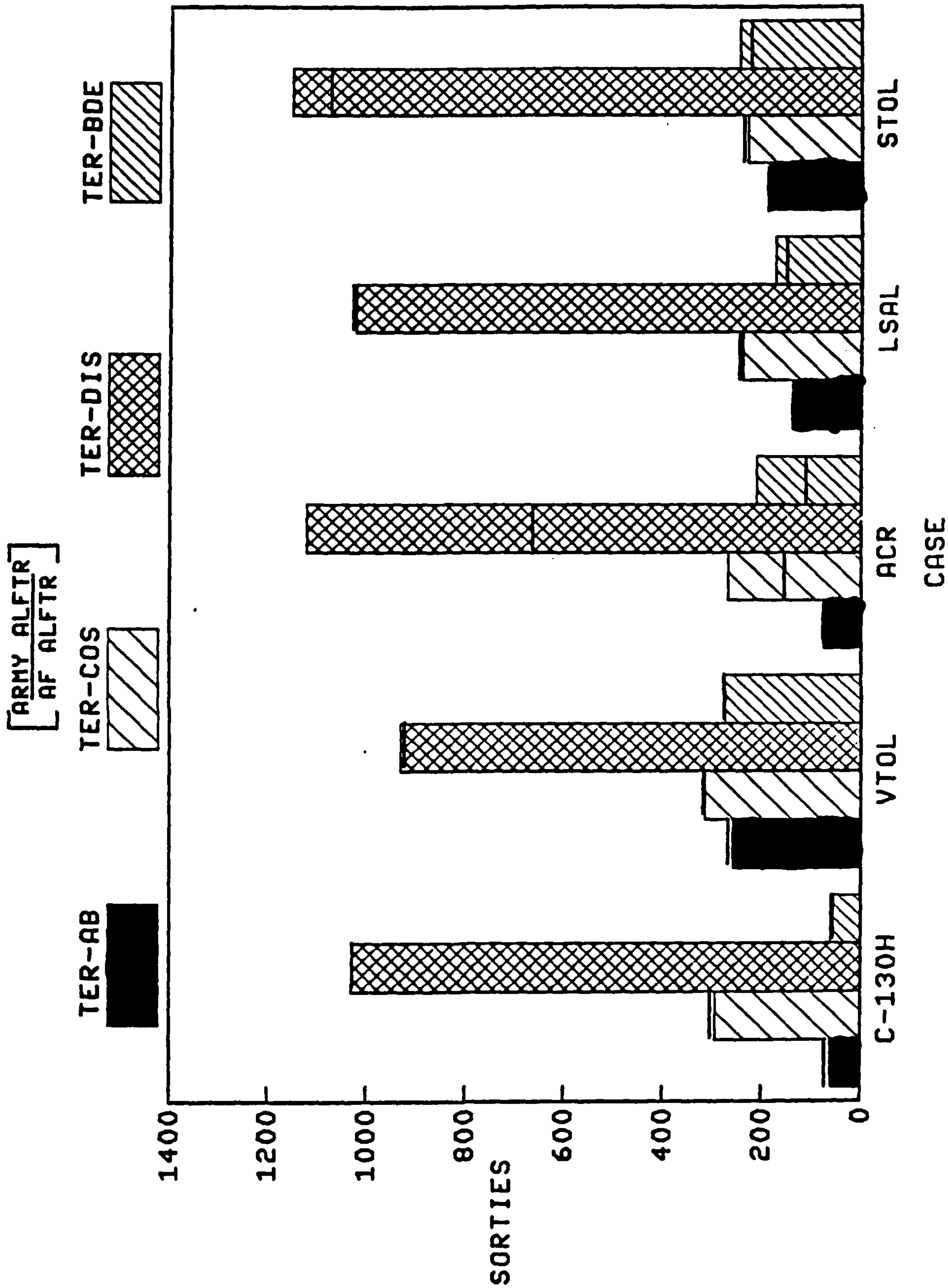


Figure 12-19. NATO - P-Sortie Distribution.

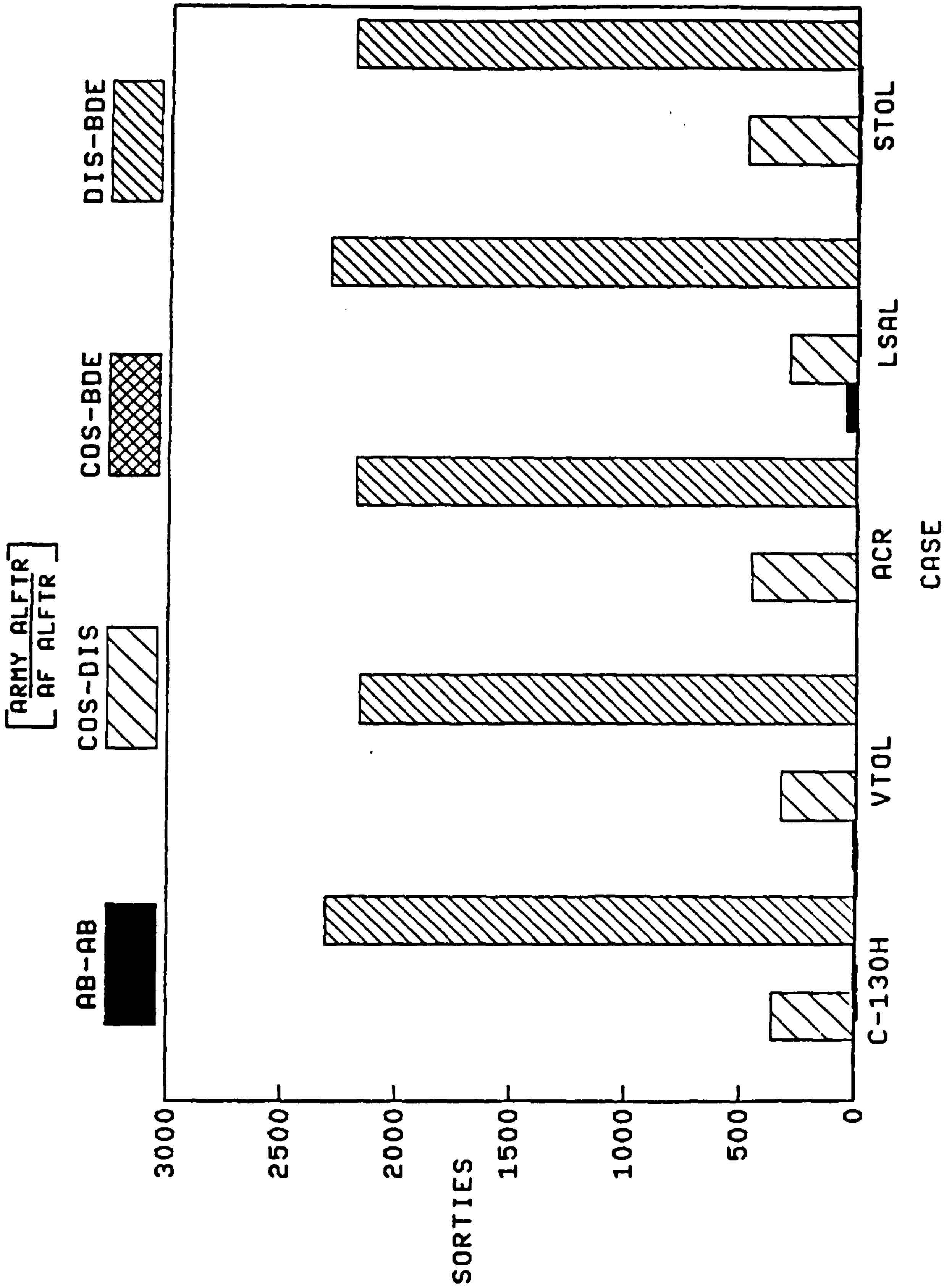


Figure 12-20. NATO - P-Sortie Distribution (#2).

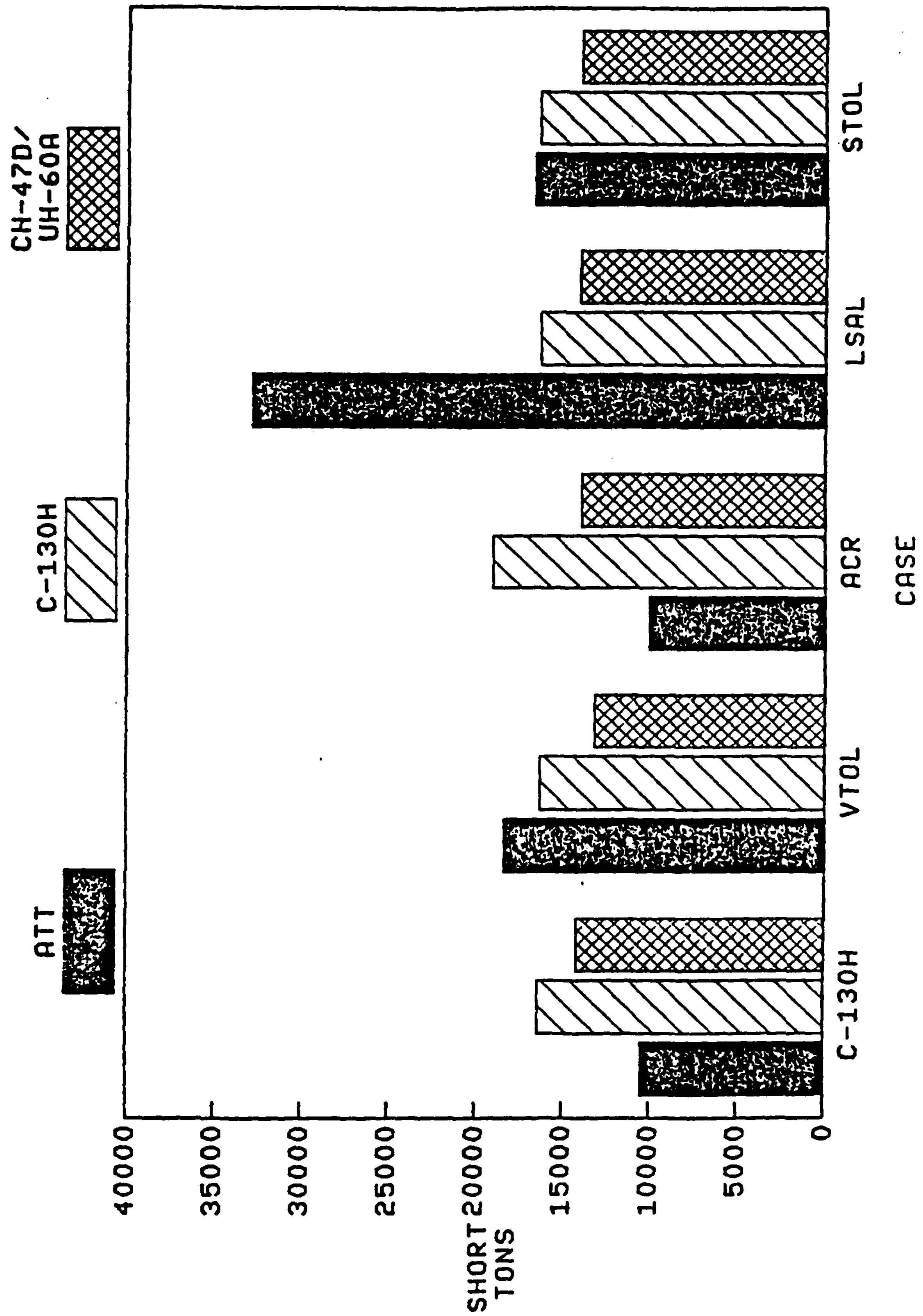


Figure 12-21. NATO - Total Airlifted Payload.

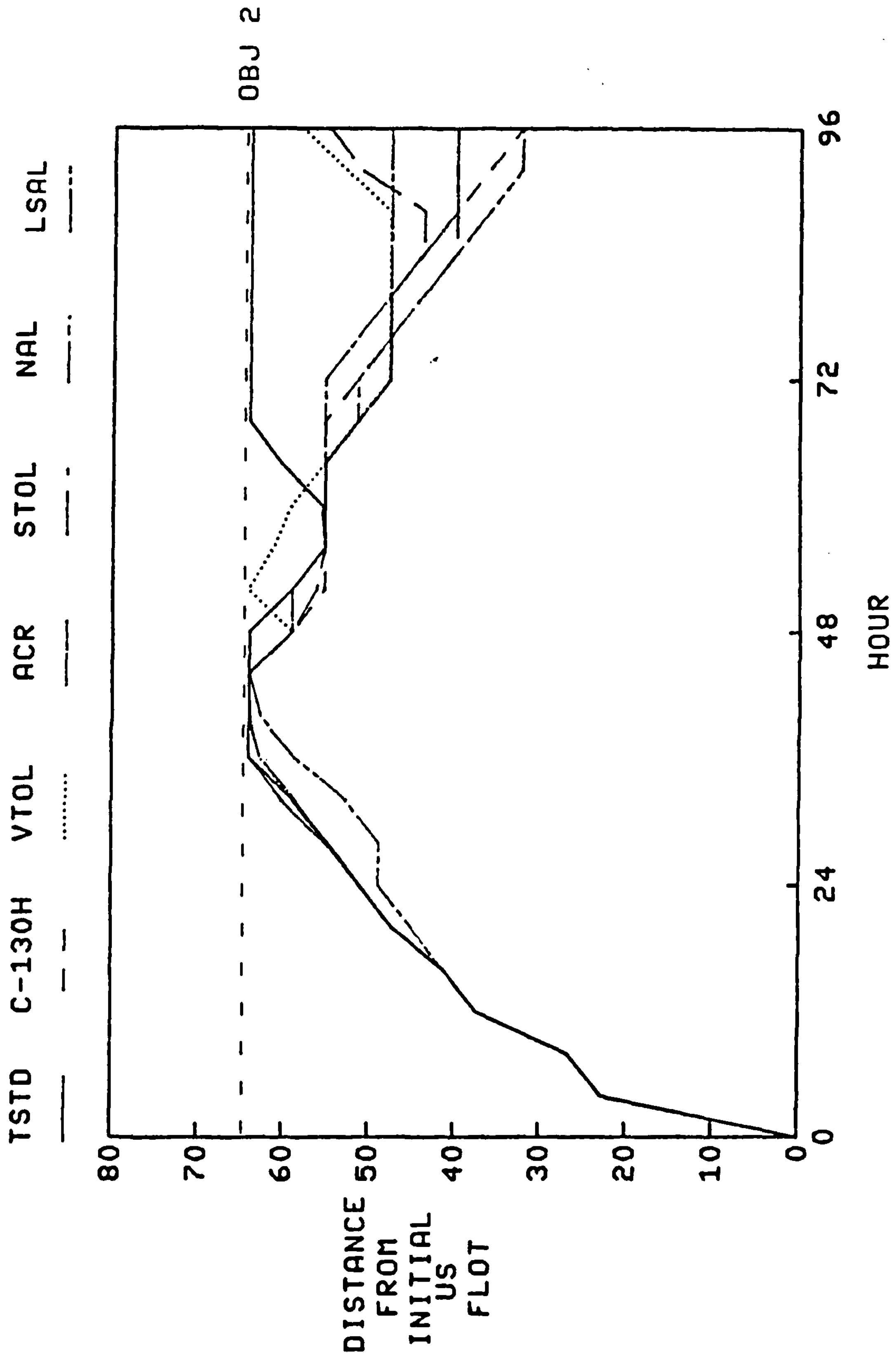


Figure 12-22. NATO - Comparative 4MD FLOT History.

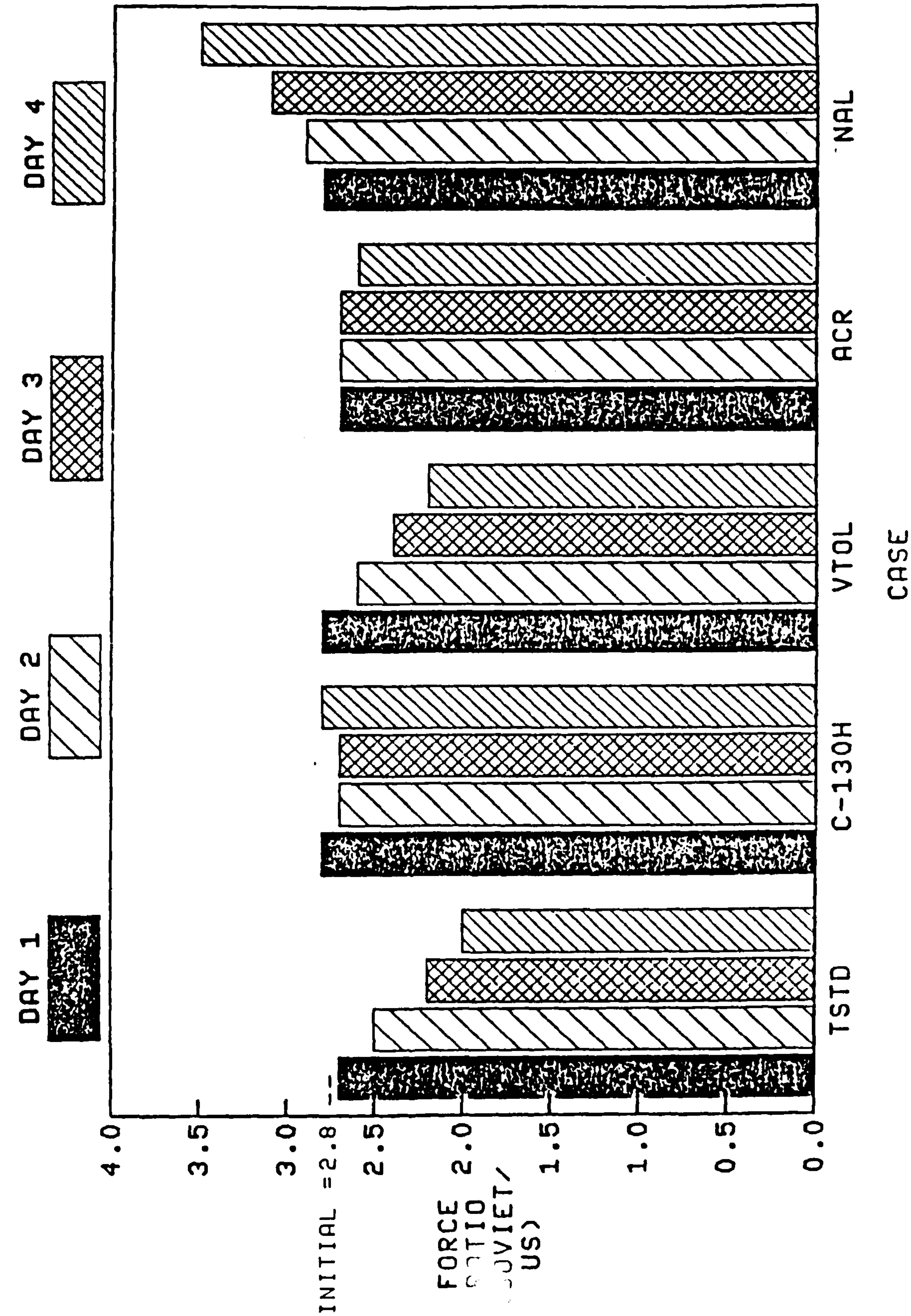


Figure 12-23. NATO - Campaign Combat Vehicle Force Ratio.

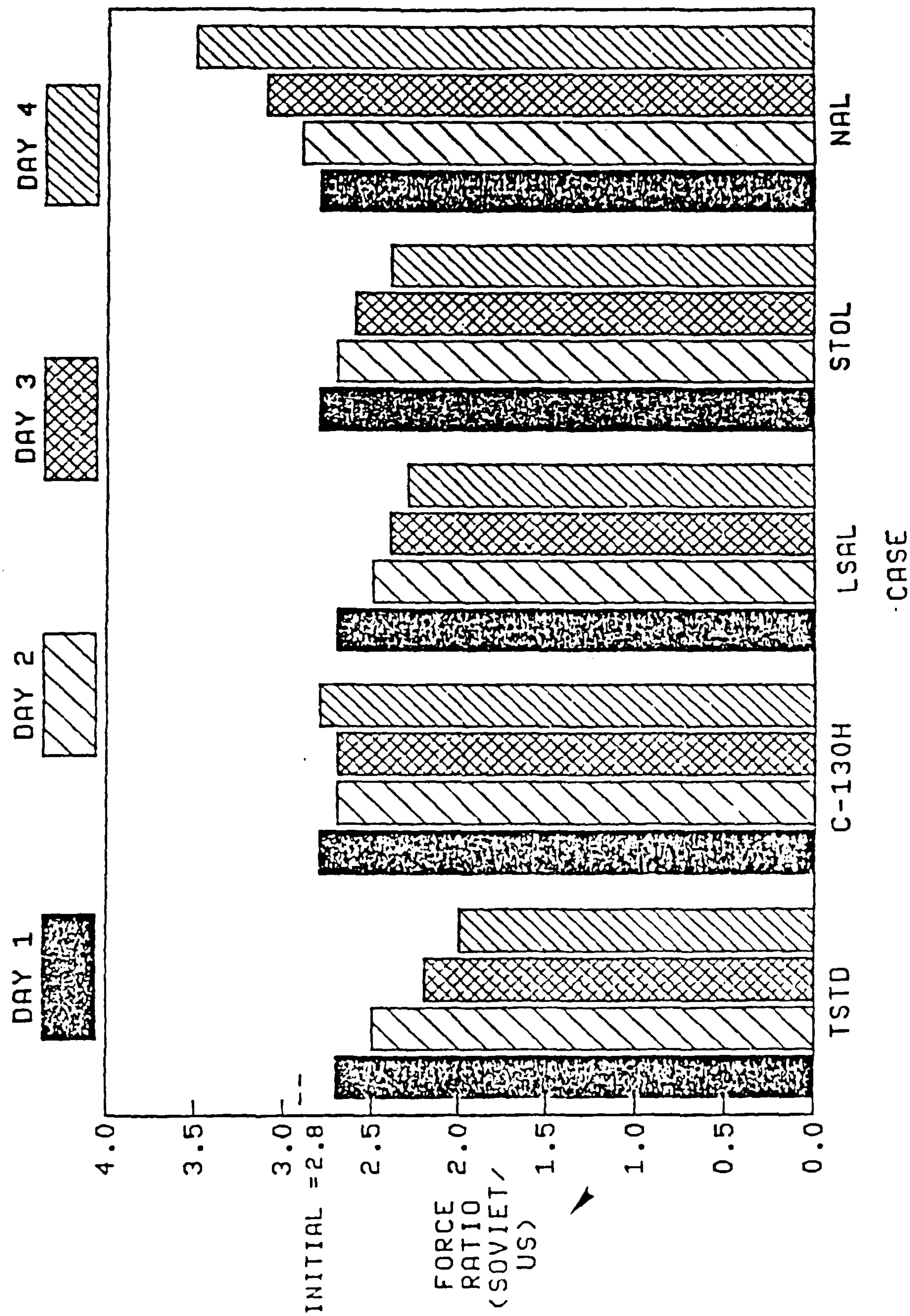


Figure 12-24. NATO - Campaign Combat Vehicle Force Ratio (#2).

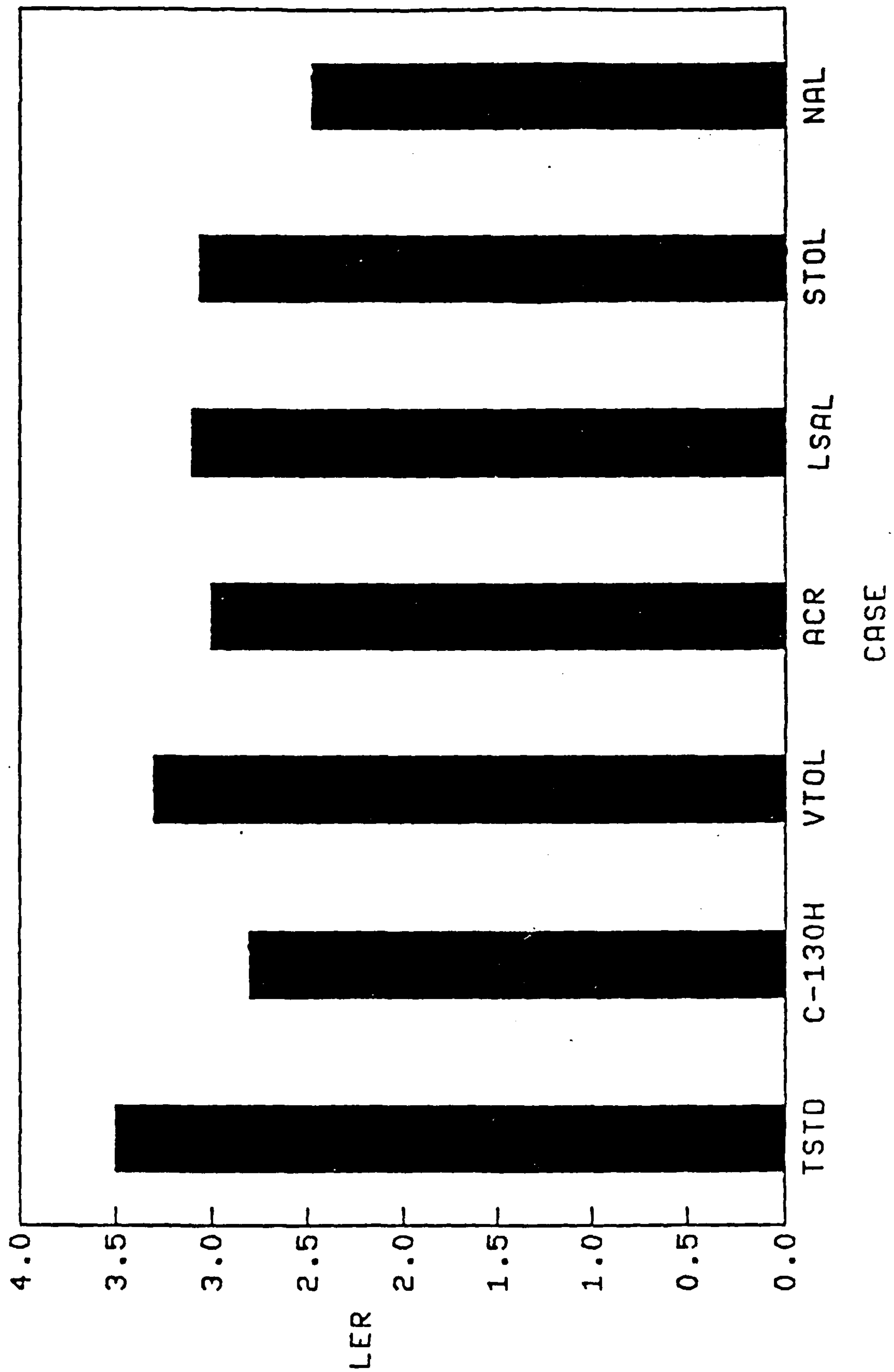


Figure 12-25. NATO - Campaign Combat Vehicle Loss Exchange Ratio.

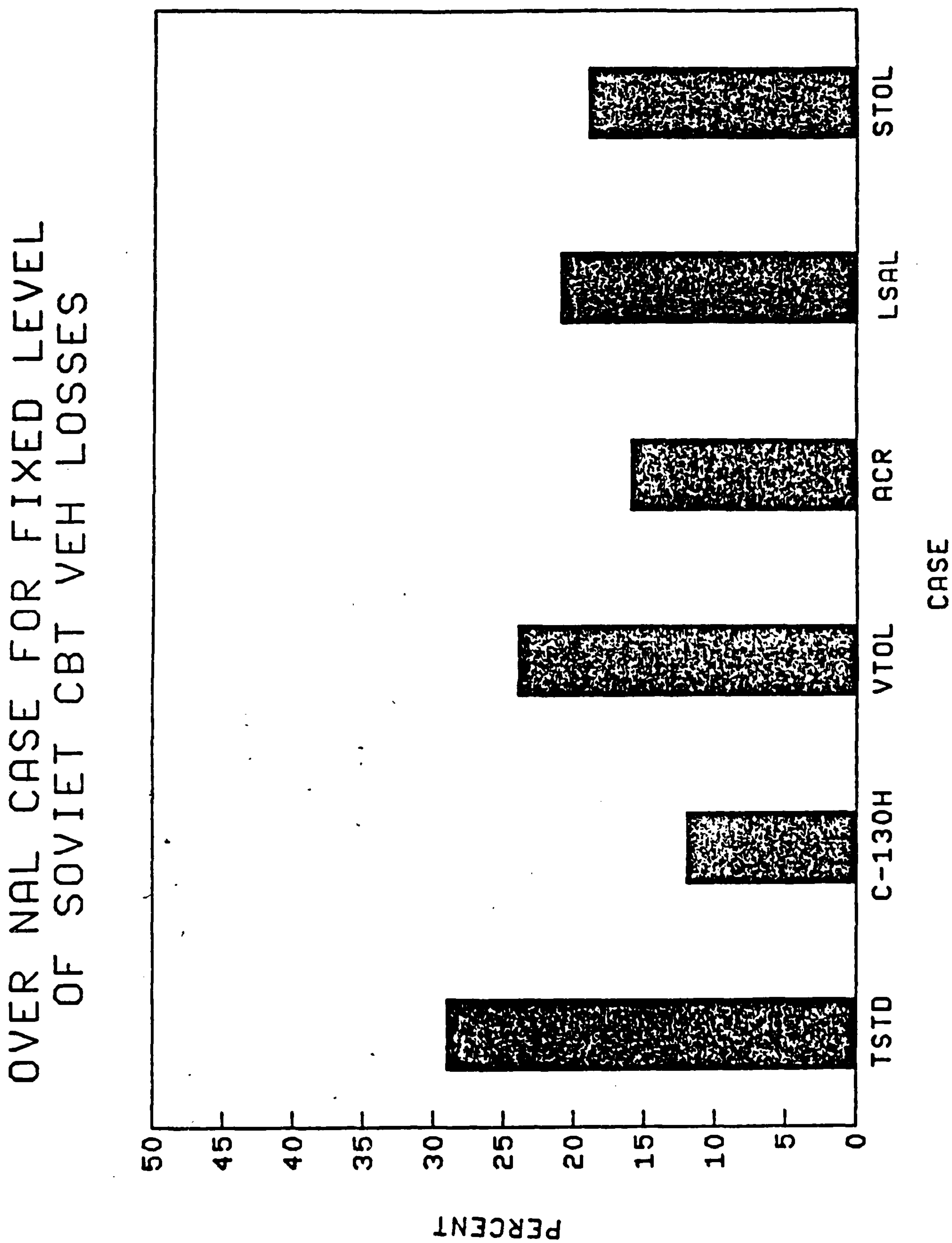


Figure 12-26. NATO - Percent Savings In US Combat Vehicle Losses.

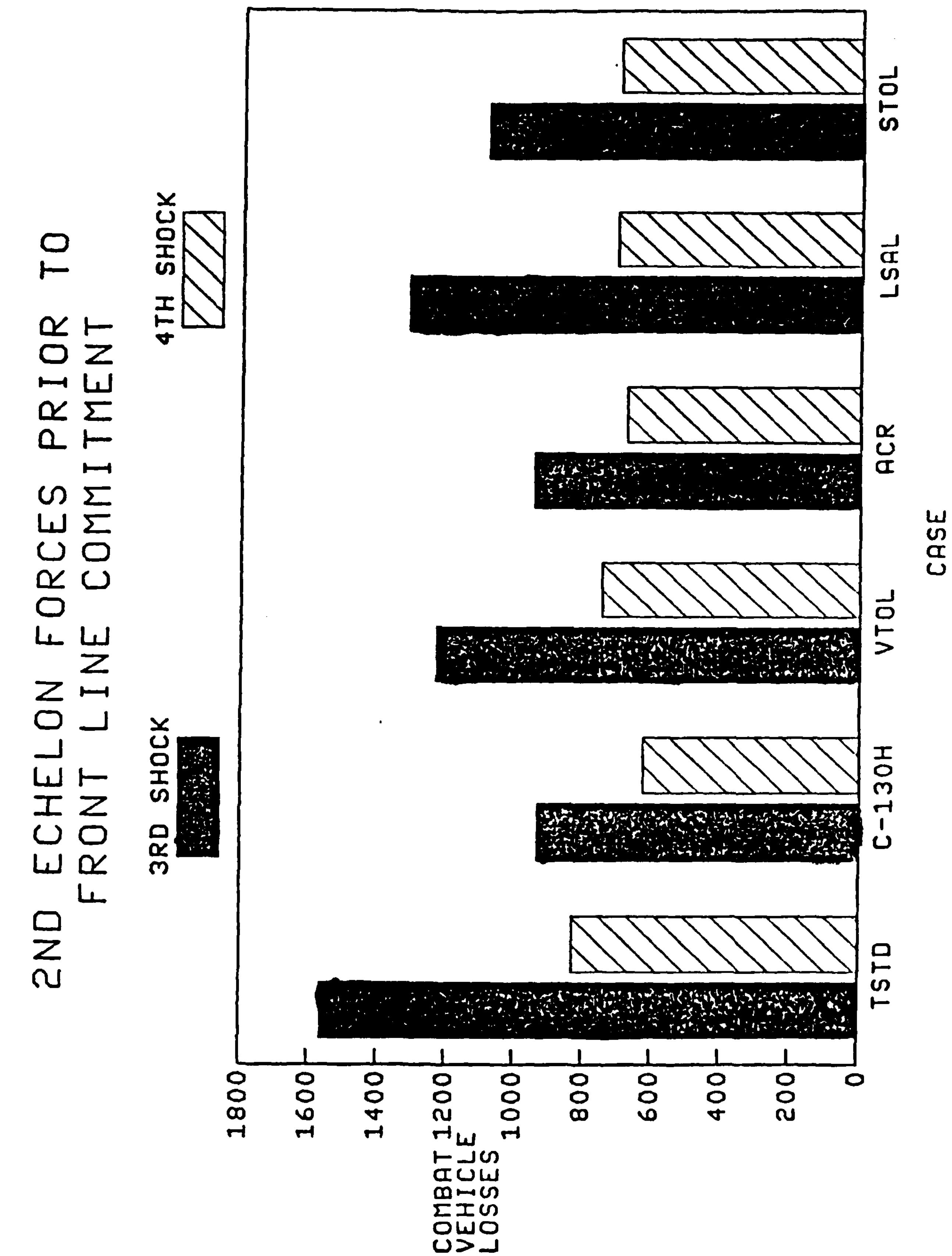


Figure 12-27. NATO - Combat Vehicle Losses Of Soviets.

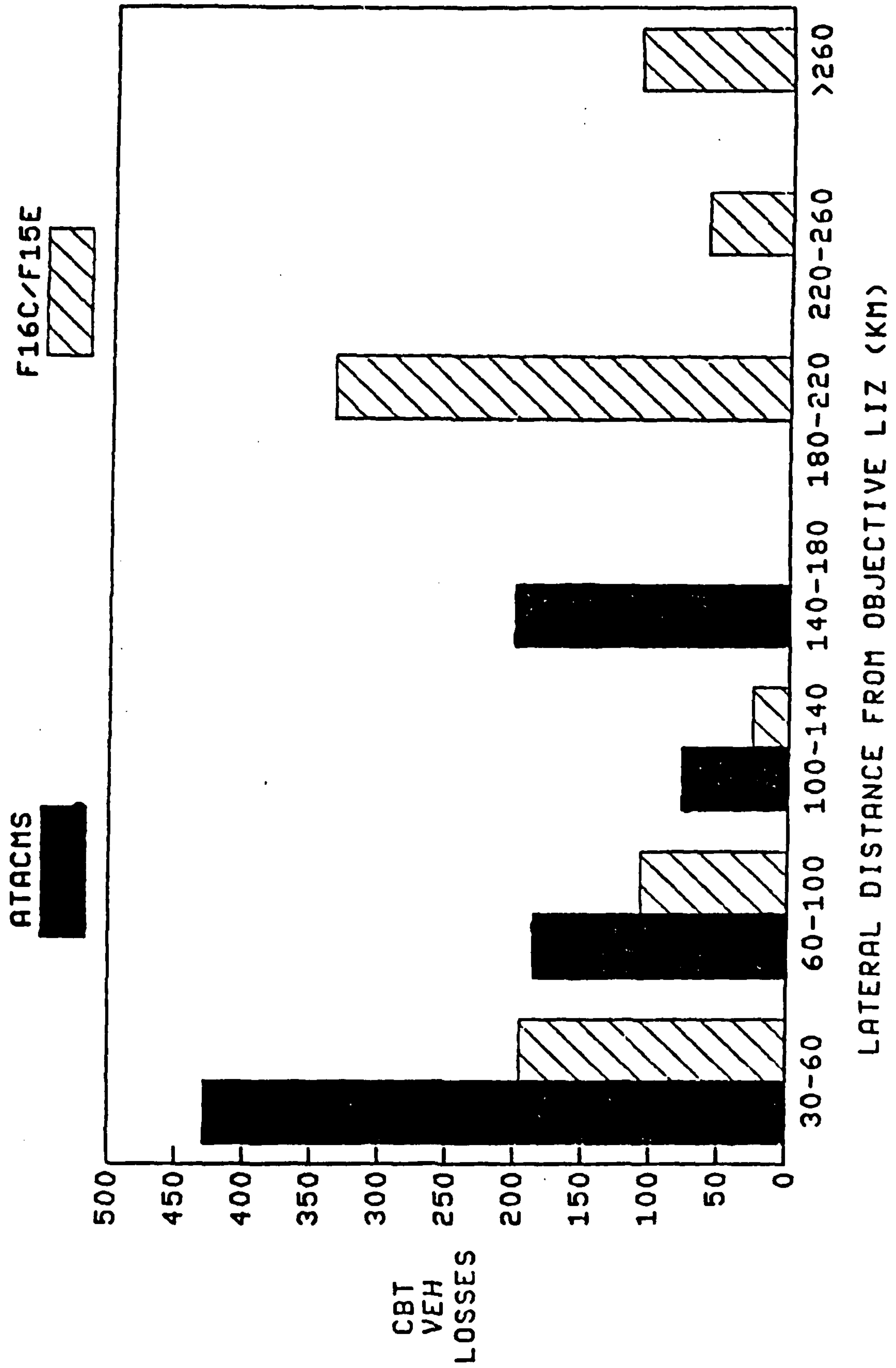


Figure 12-28. NATO - Attack Of Follow-On Forces (C-130H Case).

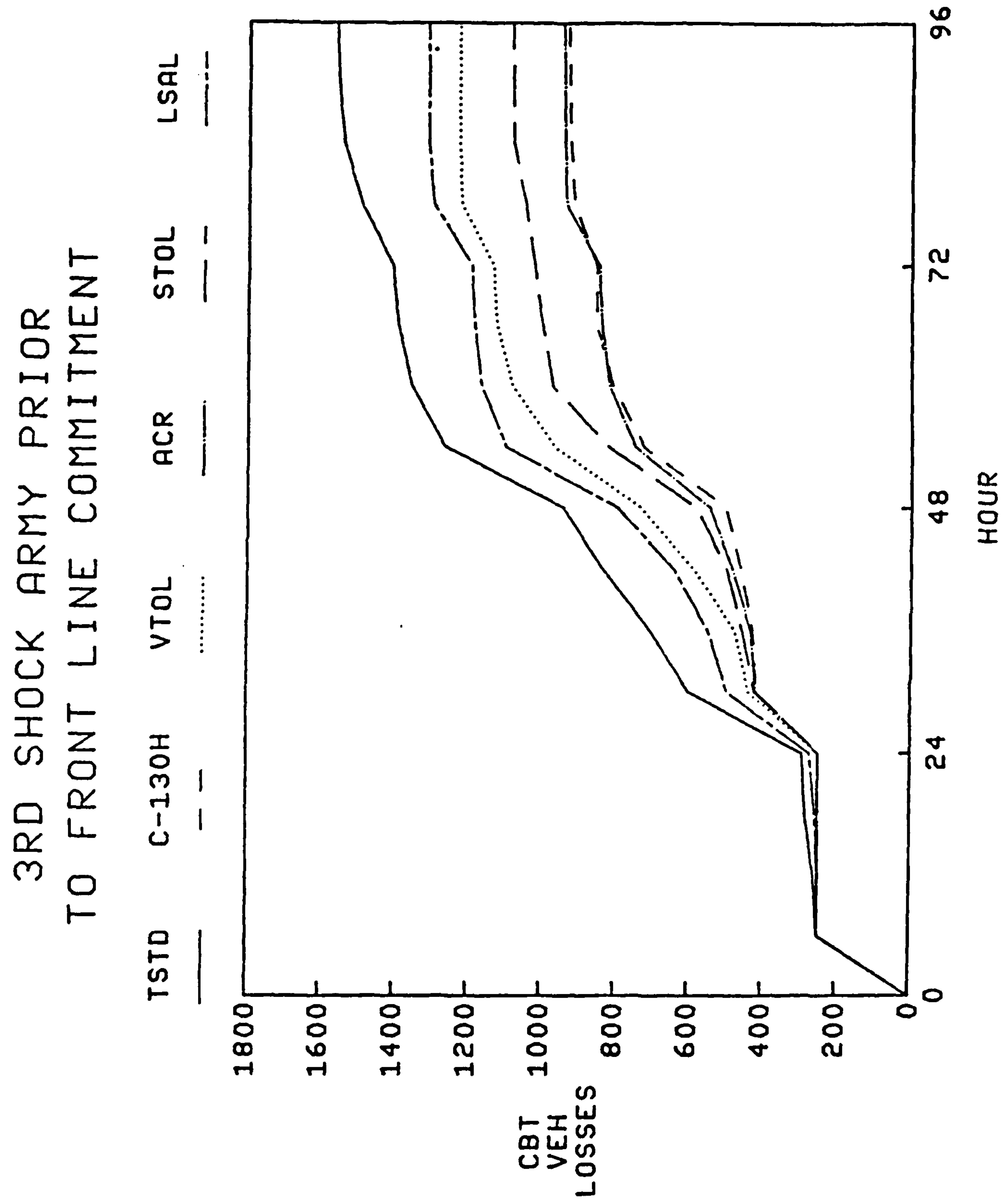


Figure 12-29. NATO - Cumulative Combat Vehicle Losses of Soviets.

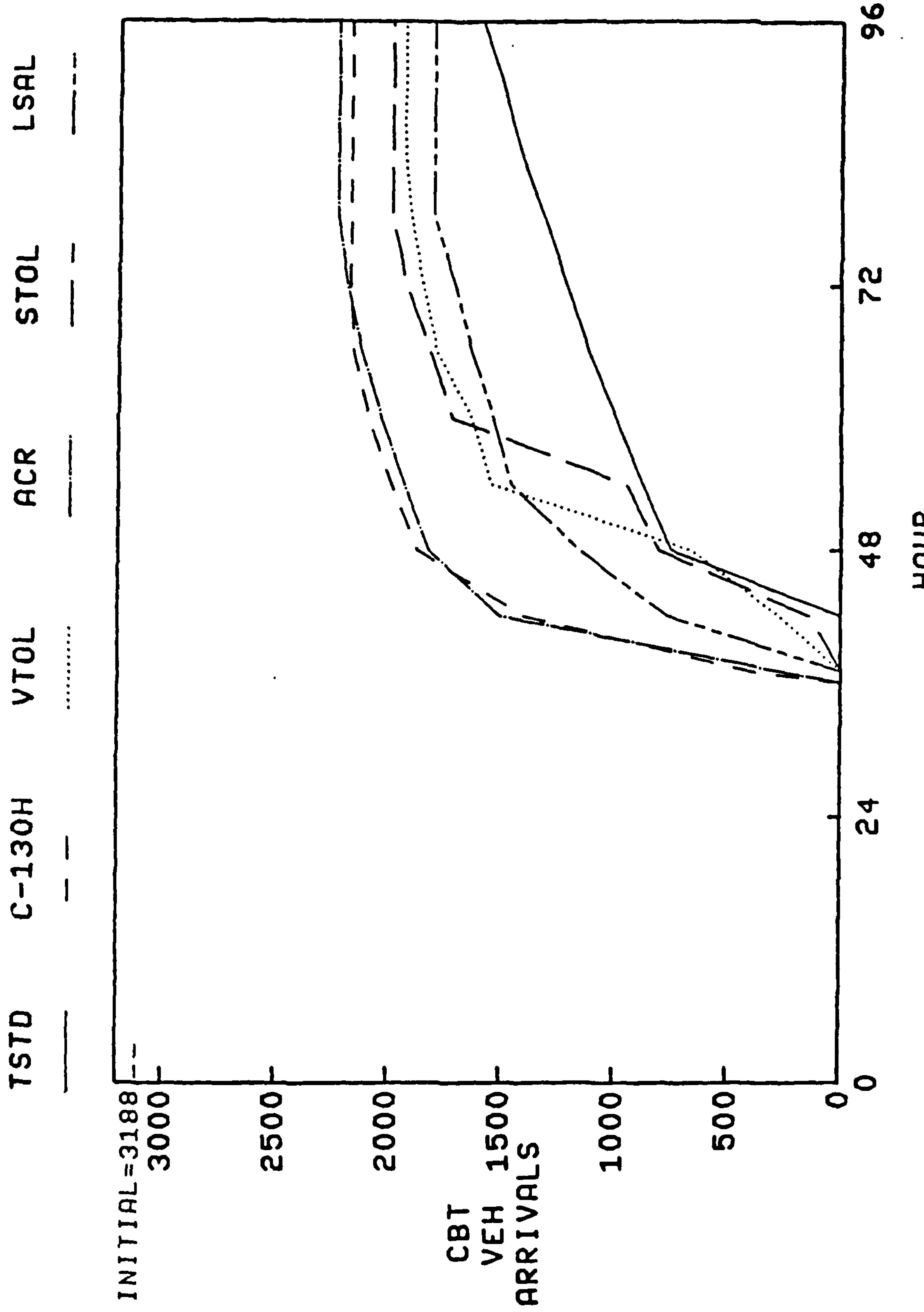


Figure 12-30. NATO - Number Of Soviet 3rd Shock Army Combat Vehicle Arrivals At Front Line.

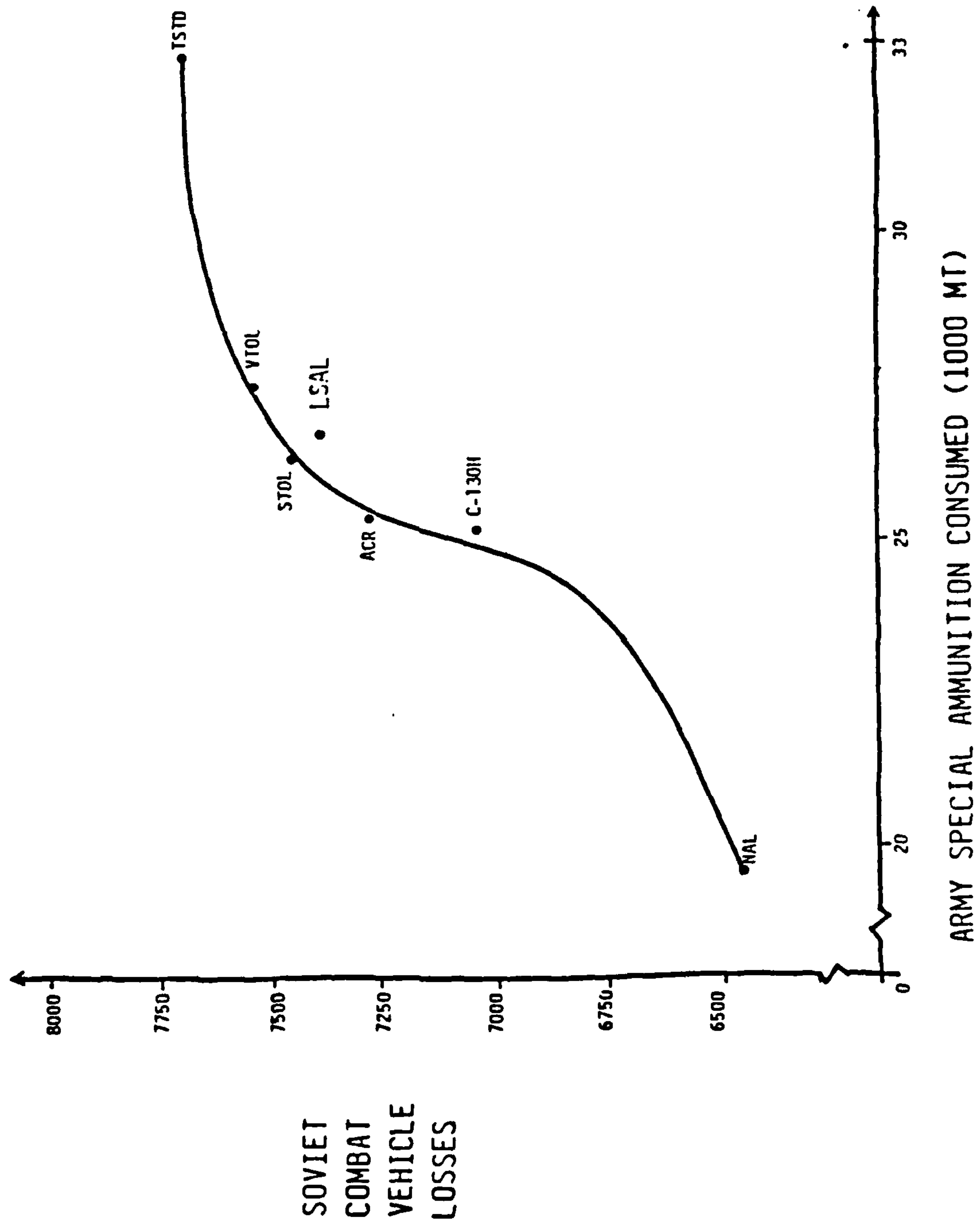


Figure 12-31. NATO - Correlation Of Soviet Combat Vehicle Losses With Army Special Ammunition Consumed.

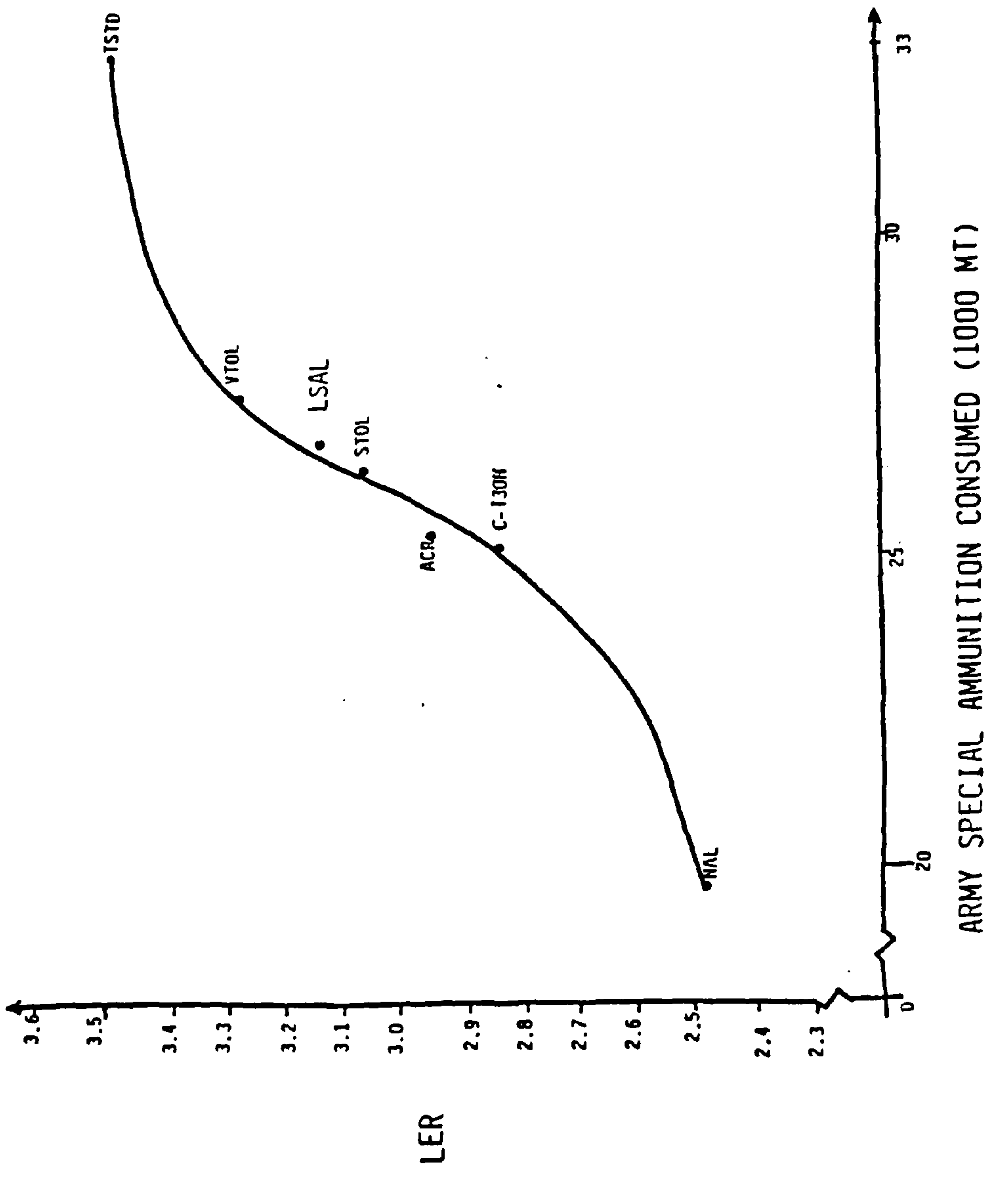


Figure 12-32. NATO - Correlation Of Overall Combat Vehicle LER With Army Special Ammunition Consumed.

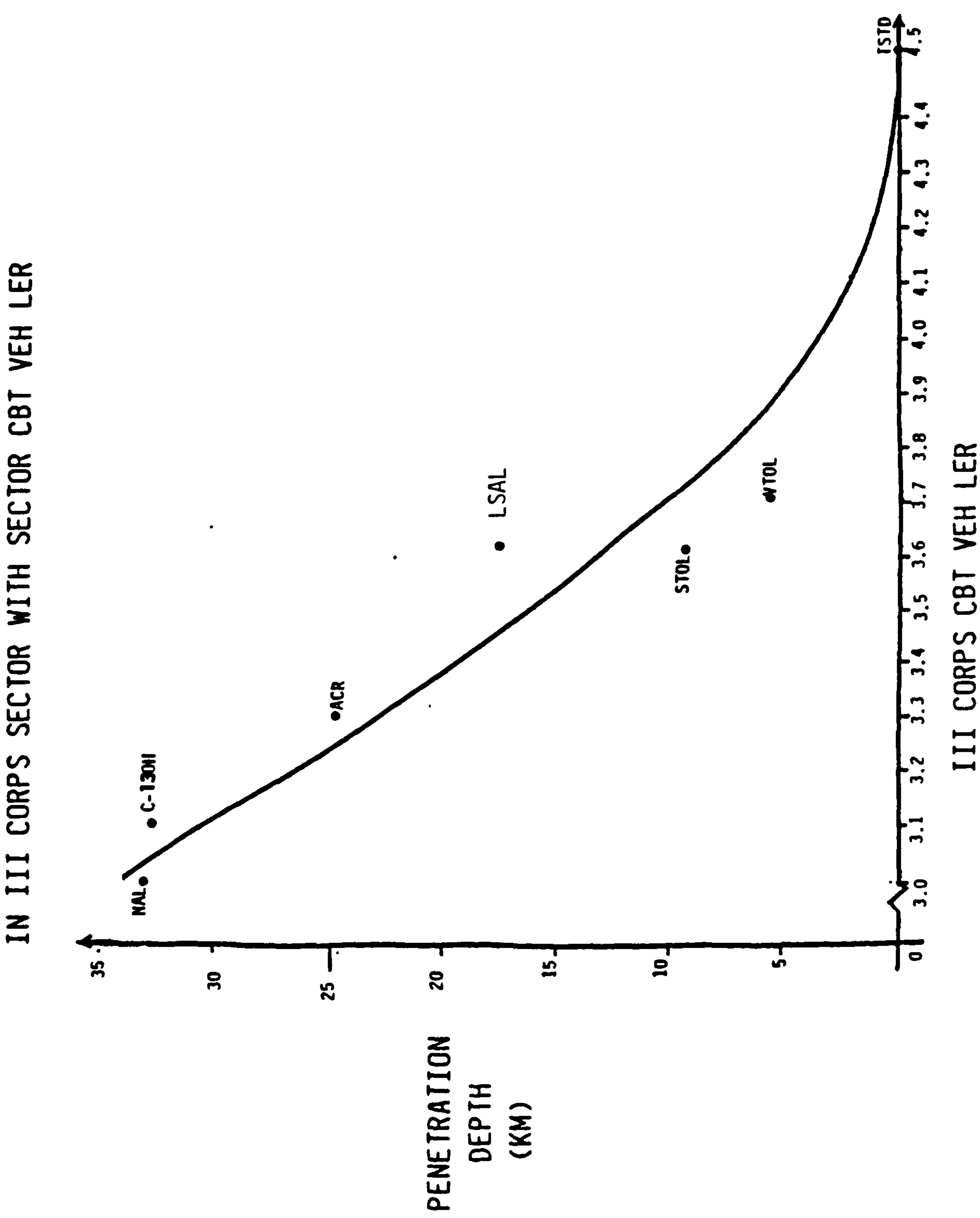


Figure 12-33. NATO - Correlation Of Soviet Counterattack Penetration With Combat Vehicle LER.

## 12.4 OBSERVATIONS AND NEEDS.

Figures 12-34 and 12-35 provide some overview observations of the SWASIA and NATO results, respectively.

The SWASIA results highlight the fire support character of the campaign with the maneuver forces conducting ambushes in order to create lucrative target complexes for fire support means to destroy. However, maneuver forces must be reinforced in a timely manner to be successful, and airlift is critical to that timely reinforcement. A primary observation is that the ability of U.S. forces to limit the advance of Soviet forces through the Zagros Mountains is correlated with the time required to complete an airlifted unit move and with the distance the reinforcing unit is required to move. There is also a correlation between the supplies shipped and the ordnance/ ammunition consumed with the surviving force ratio. Finally, the ability of airlift aircraft to use short airfields or no airfields made the defense of the Khuzistan Oil Fields more successful.

NATO results highlighted the importance of attacking Soviet follow-on forces by tactical air and artillery. It is also clear that the outcome of a campaign was related to the effectiveness of all airlift. Airlift moved supplies predominately from terminals to DISCOM and Brigade Trains. The different ATTs varied in their ability to deliver ammunition to the user where and when needed. The ability to use non-airfields for priority resupply to Brigade Trains and for unit moves to airheads was identified as a priority requirement for airlift.

OPERATIONAL CONCEPT OF CENTCOM FORCES DEFENDING HEAVILY IN ZAGROS MOUNTAINS APPEARS TO BE EFFECTIVE.

RESULTS HIGHLIGHT FIRE SUPPORT CHARACTER OF CAMPAIGN. MANEUVER FORCES CONDUCT MOUNTAIN BLOCKING POSITION (MBP) AMBUSHES TO CREATE LUCRATIVE TARGET COMPLEXES FOR FIRE SUPPORT MEANS.

MBP AMBUSHES CRITICAL TO SUCCESS OF CAMPAIGN. MANEUVER FORCES MUST BE REINFORCED IN TIMELY MANNER TO CAUSE CONTINUAL DELAY OF SOVIET FORCES.

OBTAINING AIR SUPERIORITY EARLY IN CAMPAIGN ESSENTIAL TO ITS SUCCESS.

SUCCESS OF THE CAMPAIGN HIGHLY DEPENDENT ON AIR FORCE AND ARMY AIRLIFT FOR REINFORCEMENT.

CENTCOM FORCES ABILITY TO LIMIT ADVANCE OF SOVIET FORCE THROUGH THE ZAGROS MOUNTAINS APPEARS CORRELATED WITH TIME TO COMPLETE AN AIRLIFTED UNIT MOVE AND DISTANCE REINFORCING UNIT IS DELIVERED FROM SUPPORTED ONE.

PROVISIONING OF ORDNANCE/AMMUNITION AND POL SIGNIFICANTLY AFFECTS ABILITY TO PRODUCE FAVORABLE SURVIVING FORCE RATIOS. THERE IS A CORRELATION BETWEEN SUPPLIES SHIPPED AND ORDNANCE/AMMUNITION CONSUMED WITH SURVIVING FORCE RATIO.

DEFENSE OF KHUZISTAN OIL FIELDS WAS MADE MORE SUCCESSFUL THROUGH THE USE OF SHORT AIRFIELDS AND NON-AIRFIELDS (WHERE FEASIBLE).

THE STANDARD AIR FORCE AERIEL PORT ELEMENT (APE) DEPLOYMENT PACKAGE WAS INADEQUATE TO HANDLE FLOW THROUGH A NUMBER OF DELIVERY AIRFIELDS. CAUSED THROUGHPUT CONSTRAINTS, INSUFFICIENT USE OF AIRCRAFT, AND LONGER MISSION DURATIONS.

Figure 12-34. Some Overview Observations Of SWASIA Results.

CAN PINCH OFF PENETRATION AND HOLD 3RD SHOCK. 4TH SHOCK WILL STRESS SURVIVING FORCES.

ATTACK OF SOVIET FOLLOW-ON FORCES BY TAC AIR AND ARTILLERY CRITICAL TO SUCCESS. COORDINATION BETWEEN ATACMS AND BAI/AI MISSIONS IMPORTANT.

OUTCOME OF AIRLAND CAMPAIGN RELATED TO EFFECTIVENESS OF AF AND ARMY AIRLIFT.

CONTRIBUTION OF AIRLIFTERS RELATED TO ABILITY TO SATISFY <u>RESPONSIVELY</u> VERY HEAVY DEMAND FOR ARMY AMMO, PARTICULARLY SPECIAL AMMO. (AMMO 70-80 PERCENT OF TOTAL TONNAGE SHIPPED.) CLEAR CORRELATION BETWEEN MANY CAMPAIGN EFFECTIVENESS MEASURES AND SPECIAL AMMO CONSUMED.

WITH EXCEPTION OF AIRHEAD OPERATION, TRANSPORT SYSTEM CAPABILITY TO AIRLIFT UNITS LESS IMPORTANT TO CAMPAIGN SUCCESS THAN RESUPPLY ROLE.

AIRLIFT SUPPLY PREDOMINATLY FROM TERMINALS TO DISCOM AND BDE TRAINS. CH-47D, UH-60A, TRUCKS PLAY HEAVY ROLE IN DISCOM TO BDE TRAIN MOVES. TRUCKS MOVE 65-70 PERCENT OF TOTAL TONNAGE.

AMOUNT OF ARMY AMMO <u>SHIPPED</u> FROM TERMINALS DID NOT VARY SIGNIFICANTLY AMONG ATT CASES. AMOUNT <u>CONSUMED</u> DID. ATT DIFFER IN ABILITY TO DELIVER AMMO <u>TO THE USER</u> WHERE AND WHEN NEEDED.

SUPPORT OF CAMPAIGN BY AIR FORCE AND ARMY AIRLIFTERS SYSTEM REQUIRED EXTENSIVE USE OF NON-AIRFIELDS (WHERE FEASIBLE) FOR PRIORITY RESUPPLY TO BDE TRAINS AND FOR THE UNIT MOVE TO THE AIRHEAD.

EXTREMELY HIGH THROUGHPUT AT AIRFIELDS RELATIVE TO THEIR EXPECTED APE/MHE RESOURCES.

STRATEGIC DELIVERY OF AIR FORCE SPECIAL AMMO FROM CONUS TO TACTICAL AIR BASES IMPORTANT AND VALUABLE CONCEPT.

Figure 12-35. Some Overview Observations Of NATO Results.

Figure 12-36 summarizes the needs identified for an advanced tactical airlifter in the two scenarios in this study . The two lists of needs are in priority order and are very similar. Note that large payload capacity has only negative effects in SWASIA while it has both positive and negative effects in NATO.

Based upon this needs analysis, it is clear that the requirement for an advanced tactical transport stems from the need to support forces in SWASIA. The U.S. cannot adequately defend the Khuzistan oil fields without the capability to responsively relocate combat forces as needed throughout the theater. In addition, the NATO evaluation shows the additional utility of an advanced tactical transport in a different theater. The increases in campaign effectiveness obtained by using an advanced technology airlifter <u>might</u> be achieved by increasing the C-130H fleet size used in the NATO study.

## SWASIA

- TAKEOFF/LANDING PERFORMANCE:
  - OFF-AIRFIELD CAPABILITY
    - RESPONSIVE UNIT MOVES
    - REDUCE DISCOM THROUGHPUT CONSTRAINTS (LOAD/UNLOAD, MOG, APE)
  - SHORT (≤1500 FT) UNPREPARED STRIP CAPABILITY
- LOAD/UNLOAD TIME
- MOG
- PAYLOAD: 45,000 - 50,000 LBS ADEQUATE (>50,000 HAS NEGATIVE EFFECTS)
- RADIUS: 500 - 1,000 NM ADEQUATE[1]
- SPEED: 300 - 450 KNOTS ADEQUATE[1]

---

- APE: AIRLIFTER THAT REQUIRES LESS TO REDUCE THROUGHPUT CONSTRAINTS
- FLYING TIME: ADEQUATE FLEET SIZE

## NATO

- TAKEOFF AND LANDING PERFORMANCE:
  - OFF-AIRFIELD CAPABILITY
    - SUPPLY BRIGADE TRAINS
    - REDUCE DISCOM THROUGHPUT CONSTRAINTS (LOAD/UNLOAD, MOG)
  - SHORT (≤1500 FT) UNPREPARED STRIP CAPABILITY
- LOAD/UNLOAD TIME AND MOG
- PAYLOAD: 45,000 - 50,000 LBS ADEQUATE (>50,000 HAS POSITIVE AND NEGATIVE EFFECTS)
- RADIUS: 500 - 1,000 NM ADEQUATE[2]
- SPEED: 300 - 450 KNOTS ADEQUATE[2]

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- APE: ADEQUATE (BY POLICY)
- FLYING TIME: FLEET SIZE STRESSED

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[1] ACR CAPABILITY APPEARS ADEQUATE IF DEPLOYED AS IN SWASIA SCENARIO.

[2] ACR CAPABILITY <u>MAY BE</u> ADEQUATE IF DEPLOYED AT COSCOM/DISCOM, NOT TERMINALS.

Figure 12-36. Tactical Airlifter Needs.

Among his many honors, Dr. Bonder is the 1986 recipient of MORS prestigious Vance Wanner Memorial Award. The purpose of the Wanner Award is to recognize those who, in addition to demonstrated sustained excellence in military operations research, have distinguished themselves as leaders in the practice, management, or teaching of the profession over a period of time and who have also contributed significantly to the Military Operations Research Society. The following are excerpts from the citation for that award:

"Dr. Bonder was a professor of operations research and Director of the Systems Research Laboratory at the University of Michigan. He was a founder of Vector Research, Incorporated. Through his professorship and his leadership at Vector, Dr. Bonder pioneered the development of analytic and analytic-simulation hybrid models of tactical warfare. He used these structures to study the underlying physics of tactical warfare and to address a broad spectrum of defense issues....He has been advisor to senior members of OSD, the services, industry, and schools of engineering. Dr Bonder is a past president of both the Military Operations Research Society and the Operations Research Society of America. He is a member of the Army Science Board."

# APPENDIX A

## TERMS OF REFERENCE

TERMS OF REFERENCE

MORS MINI-SYMPOSIUM

ANALYSIS OF TACTICAL TRANSPORTATION: PROGRESS AND CHALLENGES

## BACKGROUND

While the dependence of combat operations on logistical support has long been recognized, the complexity of analyzing their interaction in a dynamic manner has hampered effective analysis of the combat process. This problem has been particularly evident with theater level transportation requirements to support tactical and logistical operations. In general, there has been no data base with enough detail or scope nor adequate methodologies to allow the evaluation of movement assets within the context of an entire theater. Because of the complexity and detail involved, current efforts typically suboptimize for a small segment of the total requirement and capability.

In 1984, the Senate and House Armed Services Committees asked that the Secretary of Defense conduct a comprehensive tactical mobility study for their consideration. The Worldwide Intratheater Mobility Study (WIMS) is the basis for that response which is now expected by the end of 1987. The study examines intratheater movements associated with initial unit deployments, unit relocations, movement of supplies into and out of ports and depots, and many miscellaneous movements such as medical evacuees and malpositioned cargo. All modes, including rail, highway, pipeline, air and water, are considered in the analysis.

While the availability of the WIMS effort is a primary motivation for a special MORS-sponsored session, several other significant ongoing or recently completed efforts involving the analysis of tactical transportation provide the opportunity for an unusually rich and diverse examination of related analytical processes in a complex area. Of particular interest are major efforts underway to evaluate an armored family of vehicles for the Army, and to define the requirements for a future Air Force tactical airlift aircraft.

## OBJECTIVE

This mini-symposium is intended to provide a forum for the discussion of several concurrent efforts to examine the role of theater-level transportation and distribution assets in the outcome of combat operations. The discussion of (conflicting) approaches to analyzing the impact of tactical transportation on combat operations is intended to inspire renewed interest and insight in related ongoing and future work and to generate dialogue about techniques, assumptions, and processes.

## SCOPE

The community interested in presentation of these efforts includes military agencies and civilian contractors involved in movement and resupply within a theater by airlift (fixed wing and helicopter), surface (highway and cross country), pipeline, rail, and water. It includes those involved in the definition of requirements, development of systems, and design of force structures.

Presentations will focus on the analytical process involved rather than stressing the results obtained. They will provide additional insight of data requirements and availability, applicable techniques and models, appropriate assumptions and scenarios, and availability of baseline work.

The mini-symposium will be held at the SECRET level to allow a full and free discussion of all material, since much of the scenario development, data bases, and results of the major presentations are classified at that level.

## AGENDA

The chairperson will develop a detailed agenda of offered and invited papers designed to accomplish the objective. Ms. Debbie Christie, OSD/PA&E, will present the Keynote address. A tentative agenda is attached to this TOR. The agenda will be finalized by the end of December 1987.

## ORGANIZATION

Dick Helmuth, MDC, will serve as chairperson of the mini-symposium. He has served as chair of Composite Working Group IV and chair of the Joint Tactical Battlefield Operations Working Group at previous MORS symposia, and will be co-chair of the Strategic Mobility Working Group at the 56th MORS Symposium. The co-chairs will be Lowell Jones, ANSER, chair of the Strategic Mobility Working Group at the 56th MORS Symposium, and Col Mike McManus, OSD/PA&E. Personnel of the MORS Office will provide necessary administrative support to include security arrangements.

## PARTICIPATION

An 'Announcement and Call for Papers' will be sent to those on the MORS mailing list who have been associated with the following MORS Working Groups: Land Warfare; Joint Tactical Battlefield Operations; Reliability, Maintainability, and Logistics; and Strategic Mobility. In addition, OSD, OJCS, Army, Navy, and Air Force agencies who are making presentations at this mini-symposium will be solicited for other agencies and contractors who might be interested in the presentations. Those organizations will be included in the mailing list for announcements. The December issue of the PHALANX will also announce the mini-symposium and invite participation. Wide interest is expected to draw 100-150 participants.

## MINI-SYMPOSIUM PRODUCTS

An unclassified Final Report will be prepared containing the presentations, either in original version or summary, for publication and distribution by MORS. An article will be prepared for PHALANX describing the mini-symposium and summarizing the presentations. Finally, a summary of the mini-symposium will be presented at the 56th MORS Symposium in a Special Session.

## SCHEDULE AND FEES

The dates for this mini-symposium are 16-17 February 1988. The program will last two full days as shown in the attached tentative agenda. Facilities of the Defense Systems Management College at Fort Belvoir, Virginia have been obtained for this event. Fees will be charged participants to cover all expenses ($85 for government, $170 for non-government personnel).

# APPENDIX B

## ANNOUNCEMENT AND CALL FOR PAPERS

# ANNOUNCEMENT AND CALL FOR PAPERS

MORS MINI-SYMPOSIUM

## Analysis of Tactical Transportation: Progress and Challenges

16-17 February 1988

**Proponent: Office of the Secretary of Defense Program Analysis & Evaluation Directorate**

MORS is the professional association of military operations analysts and users of military OA from both the military and the civilian sector.

MORS is sponsored by:

- The Deputy Undersecretary of the Army (Operations Research)
- The Director of Program Resource Appraisal, Office of the Chief of Naval Operations
- The Assistant Chief of Staff, Studies and Analyses, HQ US Air Force
- The Director for Force Structure, Resource and Assessment, Organization of the Joint Chiefs of Staff

Under the contractual sponsorship of:

- The Office of Naval Research

## PROGRAM STRUCTURE

This special mini-symposium, sponsored by MORS, has been organized to provide a forum for the discussion of the evaluation of theater-level transportation assets and their impact on the outcome of combat operations. The emphasis is on the **process** — problems encountered, methodologies developed, and challenges remaining.

The two-day program will be developed around three major study efforts: the Worldwide Intratheater Mobility Study (WIMS) by OSD(PA&E); the Advanced Tactical Transport Mission Analysis (ATTMA) by Air Force ASD/XRM; and the Armored Family of Vehicles (AFV) study by Army/TRAC. Additional presentations will be made by Debbie Christie, OSD(PA&E), and by senior representatives of the Airlift Concepts Requirements Agency (ACRA), OJCS J4, and Vector Research Incorporated (VRI).

## CALL

Additional papers on this subject are welcome and strongly encouraged. Individuals interested in presenting such work should **call** the Program Chair, Dick Helmuth, at (213) 593-7241 immediately, but no later than 10 December 1987, to discuss the paper and acceptance procedures.

## Security

The mini-symposium will be held at the SECRET level to allow a full presentation and free discussion of all material.

Attendance is by invitation only and is limited to US citizens with appropriate clearance and need-to-know certified.

## Registration Procedures

If you want to attend the mini-symposium, return the accompanying registration form immediately, along with your registration fee — $85 government; $170 non-government. Personal or company checks and government purchase orders are acceptable methods of payment.

Upon receipt of your application, the MORS office will send you the appropriate security form along with an ID card form for those who do not have an active duty or MORS ID card.

The deadline for receipt of completed registration forms, with fee attached, and completed security forms, with ID attached, is 29 January 1988.

## Logistics

The mini-symposium will be held in facilities of the Defense Systems Management College at Fort Belvoir, VA.

Arrangements have been made with the Springfield Hilton, 6550 Loisdale Road, Springfield, VA (703) 971-8900 to house the workshop participants. The rate is $61.00/single. Please make your own reservations with the Hilton. Be sure to mention you are with the MORS group.

Bus transportation will be provided to and from the workshop site. There will also be parking available for those who choose to drive. A map of *Fort Belvoir will be sent in a later mailing*

## Agenda

The mini-symposium is currently scheduled to run from 0800-1700 each day. There will be a no host mixer on Tuesday evening immediately following the sessions. Hors d'oeuvres will be provided. A tentative agenda follows.

**16 ~~15~~ February**

0800-0900 — Registration
0900-1000 — Keynote Address, Ms. Debbie Christie, OSD(PA&E)
1000-1200 — WIMS Overview, COL Mike McManus, OSD(PA&E)
1200-1300 — Lunch, Club
1300-1600 — WIMS Datab[illegible] Development and Use, COL McManus
1600-1700 — Tactical M[illegible]ity — An Airlift Perspective, COL Al Shine, ACRA
1730-1900 — No-Host Mixer, Club

**17 ~~16~~ February**

0800-0900 — Challenges in Transportation Modeling, COL Bill Smiley, JCS J4 Studies
0900-1000 — AFV with Logistics Study, TRAC, White Sands
1000-1100 — Army #2, TRAC, Fort Lee
1100-1200 — TBD
1200-1300 — Lunch, Club
1300-1400 — Development of ATT Requirements, Mr. Lud Vukmir, ASD/XR
1400-1500 — Throughput Analysis, USAF SAGM
1500-1600 — Wargame Applications, Dr. Seth Bonder, VRI
1600-1700 — Panel Discussion — Question and Answer Session with ALL Presenters

## COMMITTEE

**Program Chair** — Mr. Dick Helmuth, Douglas Aircraft Company
**Cochairs** — Mr. Lowell Jones, ANSER and COL Mike McManus, OSD/PA&E

## CAVEATS

The Military Operations Research Society does not make nor advocate official policy. Matters discussed or statements made during the mini-symposium are the sole responsibility of participants involved.

All attendees and participants are expected to submit requisite attendance forms and to pay the normal registration fees unless specifically waived by the MORS President. There is no waiver or discount for short-period attendance or participation.

Acceptance of an invitation to present a formal paper at MORS implies an obligation by the speaker to attend the mini-symposium, to provide a proper copy of the paper for the Proceedings and to submit a timely written disclosure authorization.

Security clearances must be sent in writing. MORS does not accept phoned-in clearances.

Approved: Jerome X. Goldschmidt
Contracting Officer's Technical Representative

G.H. Dimon, Jr
President

## REGISTRATION FORM

### MINI-SYMPOSIUM ON ANALYSIS OF TACTICAL TRANSPORTATION

**Name:** ______________________________

**Rank/Title:** ______________________________

**Organization/Company:** ______________________________

**Address:** ______________________________

______________________________

______________________________

**Telephone:** ______________________________

**Mail this form, together with the registration fee of $85.00 for government and $170.00 for non-government to:**

MORS
101 S. Whiting Street
Suite 202
Alexandria, VA 22304

**All registration and security forms are due in by 29 January 1988.**

**If you have further questions, call the MORS office at (703) 751-7290.**

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